

THE MICRO-LEPIDOPTERAN GENUS *ECTOEDEmia* BUSCK (NEPTICULIDAE) IN NORTH AMERICA

by

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With 71 text-figures

ABSTRACT

This paper, together with the monograph by Wilkinson & Scoble (1979) forms a comprehensive taxonomic account of the genus *Ectoedemia* Busck in North America. Species are here fully diagnosed and illustrated with drawings of the external features and genitalia. Notes on their biology are also included.

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An index to the names of taxa dealt with in the present paper can be found at the end of the following paper.

INTRODUCTION

In this revision twenty-two species are considered. Five are new combinations, two are new species and nine are diagnosed and figured which have previously

been described by Wilkinson & Scoble (1979). Those species attacking bark are described at the end and form a clear group separable on the basis of genitalia from the leaf and petiole miners. In the same way other groups amongst the latter are recognisable. However, those attacking petioles, e.g. *E. populella* and *canutus*, are included in one of the groups of leaf-miners. This action is supported by the presence of an intermediate habit. In *argyropeza* the larva first bores into the petiole and later continues to mine the leaf.

Thus in *Ectoedemia* it is now definitely established that three sites of attack exist: leaf, petiole and bark. There is also a reference to attack in the cortex. Both galls and mines are found in these locations.

There has been much discussion in the past regarding the boundaries of the genus. This revision, with the advantage of additional material, sheds light on this debate.

METHODS

The methods used are similar to those given in Wilkinson & Scoble (1979) as are also the terms used, although in the five years that have elapsed since the former work was completed we have modified some of our terminology. We have come to realise that a thorough comparative morphological study of the various nepticulid genera is long overdue, not only to ascertain homologies within the group but also with other families. At present one is not always certain that parts of genitalia given the same names as those in the Ditrysia are indeed homologous. For example the interpretation of the term "saccus" by Beirne (1945) is unclear and has not been adopted by other workers to mean a part of the integument as he seems to interpret it. Here "saccus" refers to the anterior extension of the vinculum in front of the ventral plate and is the area often extended into a bilobed protrusion. Whether this is homologous with the saccus of Ditrysia is uncertain and therefore the continued use of the term is open to question.

"Pseuduncus" is a posterior extension of the tegumen and a true uncus is not present in *Ectoedemia*. However, some species have a thickened area in the region where an uncus might be expected to arise. Scoble (verbal communication) suggests that at least in the African species he has examined, the thickening represents a forward fold of the pseuduncus and therefore the uncus is still absent. Expendable material of *trinotata* would be particularly useful for the investigation of this point.

"Anellar lobes" refers to the large spines located at the end of the aedeagus. It is not always certain if they are homologous. It is assumed they provide the normal supporting role for the aedeagus. Sometimes, however, they might be more referable to the juxta or aedeagus proper.

Scale. — On the genitalia figures the scale line represents one tenth millimeter (1/10 mm) unless otherwise indicated. The magnification of the external figures can be ascertained from the *al.ex.* measurements (taken from centre of mesothorax to wing tip and doubled) given for each species.

ABBREVIATIONS

Institutes from which material was borrowed:

- USNM — United States National Museum of Natural History, Smithsonian Institution, U.S.A.
- CNC — Canadian National Collection, Biosystematics Research Institute, Ottawa, Canada
- FIS — Forest Insect Survey, British Columbia, Canada
- SOO — Forestry Service, Environment Canada, Sault Ste. Marie, Canada
- ANS — Academy of Natural Sciences, Philadelphia, U.S.A.
- BM (NH) — British Museum (Natural History), London, U.K.
- MCZ — Museum of Comparative Zoology, Cambridge, Massachusetts, U.S.A.
- DFF — Department of Fisheries and Forestry, Forestry Service, (now Environment Canada), Ste. Foy, Quebec, Canada.

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TAXONOMIC HISTORY

The question of the significance of larval feeding habit and the pattern of forewing venation has led to some confusion in the past and is now the focus of discussions on the composition of this genus and its phylogeny with respect to the other members of the family. The genus was originally described by Busck (1907) as monotypic, because the species *populella* which, despite affinities with *Stigmella* Schrank could not be included within its confines. The genus and author were cited incorrectly by Busck as *Nepticula* Zeller. His action was right but his reason was wrong. It was that the gall-forming habit of *populella* excluded it from the leaf-mining species of *Stigmella*. Busck also gives major morphological differences between the types of *Stigmella* and *Ectoedemia*, including the closed cell of the forewing venation formed by the medial cross-vein, which is actually also present in other genera. For some time Braun had been aware of the two basic forms of forewing venation, those with a medial cross-vein and those without. This feature, however, was not given taxonomic status by her for a number of reasons. Firstly, she regarded otherwise closely related species and sometimes male and female individuals of the same species as showing both conditions of the pattern of venation (Braun, 1917: 157, and figs. 1 and 2). This conclusion was the result of misidentification of a single species (*nyssaefoliella*), which she thought had both forms of venation and, more generally, is due to the absence of any study of the genital morphology at that time. Again Braun and other of her contemporary workers regarded the mining habit of the larvae as the most significant indication of phylogeny. It was not until later examination of the genital morphology that evidence in favour of uniting leaf-mining species and gall-forming species within a single genus, became available.

Beirne (1945) divided the family into two basic groups on the form of the male genitalia, those with a ring-shaped vinculum and those with an incomplete vinculum. This led him to erect the genus *Dechtiria* for those leaf-mining species with distinct differences in genitalia from the leaf-mining *Stigmella* (and *Nepticula* sensu Beirne) species. A study of the group by Svensson (1966: 200) with a comparison of genital morphology and venation of North American types, led him to synonymise the European genus *Dechtiria* with the North American *Ectoedemia* Busck. This decision has been accepted by Wilkinson & Scoble (1979), who included seven leaf-mining species, which were earlier assigned to *Stigmella*, in *Ectoedemia*. In the present study a further five species are combined with *Ectoedemia*, all of which are leaf-miners. Beirne (1945: 204) noted that in the genus *Dechtiria*, with the exception of two species only, all species formed leaf-mines which terminated in blotches. In the present revision only one included species, *virgulae*, forms a linear leaf-mine. The remainder form either true blotches or linear mines terminating in blotches.

Immediately after the publication by Zimmermann (1940) of work on the bark-miner, *Ectoedemia liebwerdella* Zimmermann, Hering (1940) erected the genus *Zimmermannia*, with this species as the type. Hering proposed this division on the basis of a difference in larval feeding habit, comparing the North American type *populella* Busck, which forms petiole galls in poplar, and the European species *liebwerdella*, which burrows in the bark of beechwood. Hering noted that the two species were indistinguishable in the pattern of wing venation but that they differed in that *liebwerdella* possesses a row of sharp bristles on the inner side of the hind-tibiae. Borkowski's study (1972: 693) points out that this character is present in all the European *Ectoedemia* species he examined, whether gall forming or bark burrowing. This view is also held here for the American species but there is some variation in the prominence of the bristles.

Schönherr (1957: 127; 1958: 6) subsequently synonymises *Zimmermannia* with *Ectoedemia* and gives it subgeneric rank. This is confirmed by Borkowski (1972), who points out that the morphological differences given by Hering are not sufficient to warrant generic status being attached to *Zimmermannia*. He also presents a summary of the treatment of the three genera at the time and supports the division of *Ectoedemia* sensu lato into three subgenera corresponding to larval feeding habit: the petiole-miners, *Ectoedemia* Busck; the leaf-miners, *Dechtiria* Beirne; and the bark-miners, *Zimmermannia* Hering. The group is treated similarly by Emmet (1976) in his revision of the British fauna.

Although Borkowski is in some doubt that sufficient work was done by Svensson in his synonymy of *Dechtiria* with *Ectoedemia*, it is felt that the work by Wilkinson & Scoble (1979) on the Canadian fauna and the present study confirms the synonymy. On the basis of genitalia and wing venation the authors also support the synonymy of *Zimmermannia* with *Ectoedemia*. However, from this study it is possible to identify morphological divisions, mainly based on genitalia structures, within the genus, which correspond with the sites of larval attack.

Johansson (1971: 241) is of the opinion that the family Nepticulidae may be split into two genera, *Nepticula* and *Trifurcula*. He argues that *Trifurcula* has been subdivided into several genera including *Ectoedemia* and *Dechtiria*, but that these should

be included as subgenera of *Trifurcula* on the basis of male genitalia. This scheme is followed more recently by Karsholt & Schmidt Nielsen (1976) in the catalogue of Danish Lepidoptera. Although there is merit in the proposal, this classification is not adopted in this revision for reasons given by Wilkinson & Scoble (1979). It was pointed out earlier that there are no significant structural differences between the bark-miners and bark gall-formers. For example, *heinrichi* and *castaneae* cannot be reliably separated without knowledge of the host plant and damage. However, examination of the genitalia figures shows that species which attack bark (whether galls or mines) have characteristic genitalia and leads one to guess at the habits of those whose life history is unknown. The three species recorded here as attacking petioles can be placed in the same morphological group on the basis of genital structures, but the group also contains leaf-miners.

TAXONOMIC CONSIDERATIONS

The similarity in morphological structures, even genitalia, between *castaneae* and *heinrichi*, highlights problems over the species concept in this group of Lepidoptera. Knowledge of the life history leads us to separate two species which otherwise might have been regarded as one. Speciation is much more extensive than has hitherto been recognised and many species are only known through the excellent rearing work of Braun and others. In this genus alone, many species are shown to have more than one form in the externals, particularly wing markings, which is not matched by differences in the genitalia. At first sight a species appears to be di- or polymorphic, but without knowledge of the life cycles, we cannot be sure that these variants are not distinct species. For example, three wing pattern forms occur in what has been called *E. similella*. Although they have identical genitalia, one form occurs in Ohio, New Jersey and Virginia, another form in Florida. A single specimen with different markings has been collected from Arkansas. Host plants are only known for the Ohio form (*Quercus palustris* and *Q. rubra*).

A specimen (nr. 7) probably represents a new species close to *rubifoliella*. It differs in ground colour and certain aspects of the genitalia. It was reared by Braun from a collection of similar mines on *Quercus platanoides* but the rest turned out to be *Stigmella flavipedella* (Braun) comb. n. This is one of a number of examples which shows that each larva should be reared separately, as far as practicable, and also have a separate rearing number. The fact that the host plants of *rubifoliella* and specimen 7 are so different, supports the view that specimen 7 should be treated as a new species but this has not been done in case there is anything spurious about its breeding record. Otherwise its similarity to *rubifoliella* is quite striking. The male genitalia figures are drawn to accentuate the differences which may not be so easy to diagnose as they at first seem.

Of course, the problem must also be approached from the other direction. It is quite possible that a species could attack more than one part of a plant. It is known that *E. argyropeza downesi* mines both the petiole and the lamina. It is also possible that the same species may create mines or galls depending upon the site of oviposition. Although many species are monophagous not all are, and we should therefore be prepared for dimorphism or different reactions from different host

plants to the same species. Some authorities think this unlikely but there is considerable danger in the philosophy — two species of host plant, therefore *ipso facto* two species of miner! However, hopefully these problems will encourage experimental work designed to discover the flexibility in miner and host plant relationships within the Nepticulidae. Meanwhile these cases underline the point that no one character, or series of characters, can be taken as necessarily species-diagnostic throughout the Nepticulidae or even for *Ectoedemia*.

There has been debate regarding the division of the genus into sub-genera and also whether *Ectoedemia* comprises, in reality, more than one genus. Much more information on life cycles is needed to answer this, but this paper shows that the criteria previously used for separations are inadequate. The genitalia structures allow us to divide *Ectoedemia* into broad groups and it seems that those species attacking bark (both mining and gall-forming) are particularly diagnostic. However, we do not yet know whether all those species assigned to the group do, in fact, attack bark. In other groups it can be argued that one or two species (*trinitata*, *nyssaefoliella*) have males belonging to a different group from the females, thus suggesting that the groups are not fundamental. Our present level of knowledge recommends us to regard these species as representing one genus and our studies of *Ectoedemia* on other continents will shed further light on these conclusions. It is interesting to note how some genera of Nepticulidae are worldwide in their distribution whilst others are comparatively localised.

GENERIC DESCRIPTION

External features: ♂ ♀. Head: palps extending well beyond labrum, pale grey or white; antennae approximately half length of forewings, pale or fuscous; tuft on front of head usually ochreous, sometimes white or brown, vertex concolourous; eye-caps always whitish; collar white or ochreous, sometimes fuscous. Thorax dark brown to black, sometimes white or buff and irrorate, usually iridescent. Abdomen grey or brown, iridescent metallic grey beneath. Venation as in figs. 1 or 2. Forewings: Media coalescing with cubitus at base and passing obliquely to radius at or beyond R_{2+3} and anastomosing beyond middle of wing; cubitus usually reaching margin; R_4 and R_5 separate; anal vein sometimes meeting cubitus distally. Hindwings: Media single-branched. Forewings: elongate and ovate in shape, ground colour of dorsal surface generally fuscous with each scale darker at the tip, rarely pale and irrorate with fuscous; fringe pale grey or brown and iridescent, usually marked apically with a band of wing-scales or variously irrorate; markings usually in the form of up to four streaks or patches, never with more than one complete fascia. Hindwings: narrow and lanceolate, sometimes with costa emarginated; pale grey or brown and sometimes with white or ochreous patches of specialised scales. Legs: grey or brown, sometimes with scattered paler areas; proximal pair of spurs on hind-tibiae at or below the middle (fig. 3); hind-tibiae with many sharp bristles inwardly directed and variable in prominence.

Male genitalia: Vinculum always ring-shaped; tegumen fused with vinculum dorsally and produced into broad tapering, pointed or bluntly rounded pseuduncus. Uncus often not readily visible, only present as membranous lobe at base of pseu-

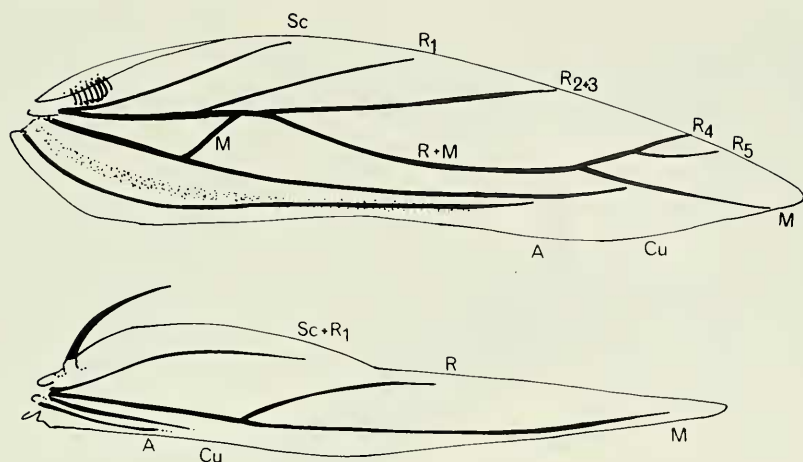
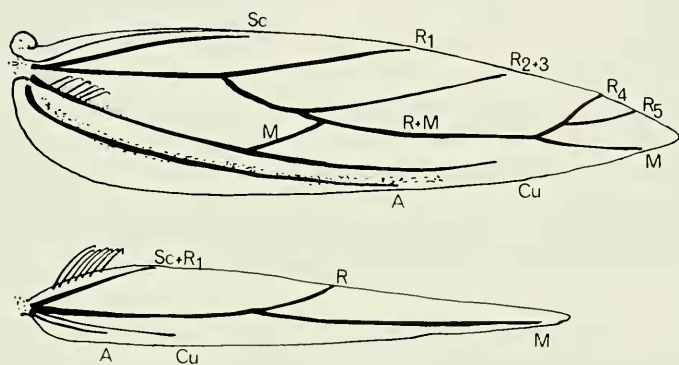
1 *Ectoedemia obrutella* ♂2 *Ectoedemia similella* ♀

Fig. 1. *Ectoedemia obrutella* (Zeller) Busck, ♂, wing venation. Fig. 2. *E. similella* (Braun), ♀, wing venation.

duncus. Gnathos with medial arms fused to form central boss or tapering process, lateral arms rarely extended or bifurcate. Saccus bilobed to various degrees. Valves usually tapering and inwardly curved distally, sometimes weakly bifurcate and in some cases adorned with digitate setae. Transtillae usually U-shaped; transverse bars continuous, fused medially. Juxta absent. Aedeagus: generally regular in shape and longer than the capsule; vesica usually adorned with small denticles and cornuti; also with a plate of minute papillae. Anellus with heavily sclerotised spines, sometimes elaborate, rarely absent.

Female genitalia: Apophyses usually shorter than ductus but posteriores very long in the *castaneae* group. Ductus at colliculum with double sclerotised ring and associated denticulate sac, or with single plate, or without sclerotisation. Bursa

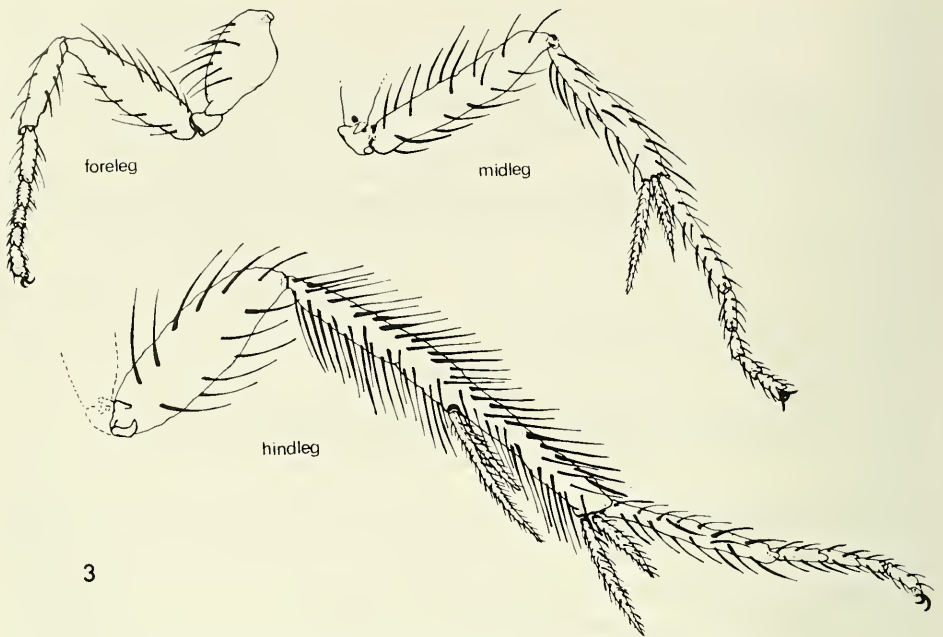


Fig. 3. *Ectoedemia* species. Legs showing position of tibial spurs.

copulatrix: large and variously pectinate; signum double, comprising ovate patches of reticulate cells.

Larvae: may be divided into three groups: leaf-miners usually forming linear tracts terminating in blotches; petiole miners and bark miners both sometimes producing galls.

GENERIC DIFFERENTIAL DIAGNOSIS

Characters which differentiate North American genera of the family Nepticulidae are given.

Ectoedemia Busck, 1907.

Venation: Media of forewing coalescing with Cubitus at base, passing obliquely to Radius at or beyond R_{2+3} and anastomosing to a point beyond middle of wing; R_4 and R_5 separate; Cubitus usually approaching margin; Media of hindwing single. Proximal pair of spurs on hind tibiae sometimes in the middle. Male genitalia with gnathos W- or V-shaped, may vary according to method of mounting; vinculum ring-shaped and without associated lateral bars; tegumen extended into tapering or lobed pseuduncus; uncus absent or weakly membranous; valves inwardly curved distally sometimes with digitate setae; juxta absent; aedeagus regular in shape with elaborate cornuti and usually anellar spines. Female genitalia with or without complex sclerotisation of the ductus and spiculate accessory lobe; apophyses shorter than ductus; signa comprising patches of reticulate cells. Larvae may mine in, or form galls on leaves, petioles, bark or cortex.

Stigmella Schrank, 1802.

Venation: Media of forewing coalescing with Radius at base and anastomosing to a point beyond the middle of the wing; R_4 coincident with R_5 ; Cubitus arising separately, approaching middle of the wing; Media of hindwing single. Forewings usually uniform and dark in colour, with one or two complete fasciae or patches; fringe with diffuse margin. Proximal pair of spurs on hind tibiae above the middle. Male genitalia usually with U-shaped vinculum; tegumen strap-like, articulating with vinculum dorsally; uncus bilobed; juxta, if present, membranous; aedeagus usually flask-shaped, vesica usually with many denticulate cornuti orientated in a ridge and rarely with plate-like cornuti at the anellus. Female genitalia with simple ductus and accessory sac; bursa copulatrix usually without signum, but if present often single and weakly sclerotised. Larvae mining leaves of trees and shrubs and sometimes herbs.

Microcalyptris Braun, 1925.

Venation: Reduced; Media of forewing coalescing with Radius from base and anastomosing to a point beyond the middle of the wing; R_4 coincident with R_5 ; Cubitus vestigial; Media of hindwing single, unbranched. Ground colour of dorsal surface of forewing usually pale and variously irrorate. Proximal pair of spurs on hind tibiae below middle. Male genitalia, with membranous pseuduncus and strongly sclerotised bridge-like uncus; sclerotised gnathos with complex anterior and posterior projections; lateral arms of vinculum usually with associated sclerotisations. Female genitalia with complex sclerotisations of the ductus; posterior apophyses very long, longer than the ductus; signa usually comprising linear row of spinose cells or plates. Larvae mining leaves.

Fomoria Beirne, 1945.

Venation: Media coalescing with Cubitus from base, both passing obliquely to Radius at R_{2+3} and anastomosing to beyond middle of wing; Cubitus becoming obsolete; R_4 and R_5 separate; Media of hindwing single, unbranched. Male genitalia with membranous pseuduncus and uncus as a spatulate sclerotisation; Y- or V-shaped gnathos; saccus weakly bilobed; valves sometimes with dorsal spine; aedeagus regular in shape and usually with complex anellar spines and cornuti. Female genitalia, colliculum with sclerotised funicular antrum or complex plates; simple ductus; signa comprising linear patches of reticulate cells. Larvae often recorded pupating within the leaf-mine.

Obrussa Braun, 1915.

Venation: Media of forewing coalescing with Cubitus at base, both passing obliquely to Radius at R_{2+3} and anastomosing to beyond middle of wing; Media and Cubitus separate terminally; R_4 and R_5 separate; Media of hindwing single. Ventral surface of forewing and dorsal surface of hindwing in males with patch of brightly coloured specialised scales. Proximal pair of tibial spurs below middle of hind tibiae. Male genitalia with ring-shaped vinculum; tegumen extended into tapering pseuduncus; convex saccus; valves blunted distally and each with large dorsal arm projecting transversely to reach opposite side of capsule; vesica with

transverse plate expanded laterally. Female genitalia with plate-like sclerotisation at colliculum; signa comprising ovate reticulate patches. Larvae only known to mine fruits of *Acer* sp.

Glaucolepis Braun, 1917.

Venation: Media of forewing coalescing with Cubitus at base, both passing obliquely to Radius at R_{2+3} and anastomosing to beyond middle of wing; Media and Cubitus separate terminally; R_4 and R_5 separate; Media of hindwing bifurcate. Hindwing of male with patch of brightly coloured specialised scales. Proximal pair of spurs on hind tibiae in the middle. Male genitalia with tegumen extending into tapering pseuduncus, gnathos with large transverse arms and medial dorso-lateral arms fusing terminally; valves markedly bifurcate distally; aedeagus with lateral cornuti extending full length of vesica and digitate distally. Female genitalia with simple ductus; signa comprising linear patches or rows of pectinations. Larvae mining leaves.

Manoneura Davis, 1979 (Replacement for homonymic name *Oligoneura* Davis, 1978).

Venation: greatly reduced; only two branches of Radius present; Media unbranched and arising from stem of R_{4+5} ; Cubitus absent; hindwing extremely slender and Media unbranched. Forewing dark fuscous with a single, narrow, pale golden yellow fascia at distal third. Proximal pair of spurs on hind tibiae near apex. Male genitalia with uncus vestigial; gnathos well developed, complex, consisting of two, largely separate, transverse sclerites of a highly irregular, but symmetrical outline; vinculum broad, quadrate; aedeagus moderately short and stout, with a relatively complex apex and no cornuti. Female genitalia unknown. Presumably a leaf mining genus. The type-species mines *Coccoloba uvifera* (L.).

Artaversala Davis, 1978.

Venation: greatly reduced; Radius unbranched, terminating well short of apex; Media unbranched, extending almost to apex; Cubitus shortened, indistinctly present; hindwing extremely slender and Media unbranched. Forewings with a pale yellow to whitish apex and a single, broad, median fascia. Proximal pair of spurs on hind tibiae near apex. Male genitalia with tegumen reduced to an extremely slender dorsal ring; uncus absent; vinculum well developed and V-shaped valves deeply divided and aedeagus relatively simple, without cornuti. Female genitalia with slender and elongate ductus; bursa copulatrix membranous; signa absent. Larvae mining leaves.

CHECK-LIST TO GENUS, SPECIES AND SUBSPECIES

- Ectoedemia* Busck, 1907. Type-species by original designation and monotypy: *Ectoedemia populella* Busck.
Zimmermannia Hering, 1940. Type-species by original designation: *Ectoedemia liebwerdella* Zimmermann, 1940: 264.
Dechtiria Beirne, 1945. Type-species by original designation: *Tinea subbimaculella* Haworth, 1828: 583.

populella Busck, 1907
argyropeza downesi Wilkinson & Scoble, 1979¹⁾
canutus Wilkinson & Scoble, 1979
trinotata (Braun, 1914)
marmaropa (Braun, 1925)
platanella (Clemens, 1861)
maximella (Chambers, 1873)
clemensella (Chambers, 1873)
similella (Braun, 1917)
virgulae (Braun, 1927)
lindquisti (Freeman, 1962)
rubifoliella (Clemens, 1860)
ulmella (Braun, 1912)
nyssaefoliella (Chambers, 1880)
quadrinotata (Braun, 1917)
obrutella (Zeller, 1873)
bosquella (Chambers in Hayden, 1878a)
acanthella sp.n.
piperella sp.n.
heinrichi Busck, 1914a
castaneae Busck, 1913
phleophaga Busck, 1914b
chlorantis Meyrick, 1928a
mesoloba Davis, 1978

KEY TO THE SPECIES OF NORTH AMERICAN *Ectoedemia*

1. Male genitalia with aedeagus totally lacking anellar projections. Female genitalia with excessively broad anterior apophyses together with unequal signa and no colliculum 2
- Male genitalia with anellar spines on aedeagus. Female genitalia without above combination of characters 3
2. Male genitalia with valves relatively short; as in fig. 28. Female genitalia as in fig. 29. Externals as in figs. 58, ♂, 59, ♀. Larva forms ophistigmatonome on *Nyssa* leaves *nyssaefoliella* (p. 67)
- Male genitalia with valves relatively long; as in fig. 30. Externals as in fig. 60. Female not known specimen 8 (p. 70)
3. Male genitalia with long tapering pseuduncus extending well beyond valves. Female genitalia with strongly sclerotised colliculum in the form of loops. Leaf and petiole miners and petiole gall formers 4
- Male genitalia with large rounded pseuduncus not usually projecting beyond valves and never far beyond. Female genitalia without colliculum or if weakly sclerotised, never in form of loops. Mostly species attacking bark 13
4. Male genitalia with palmate setae on the dorsal surface of valves, (not well developed in one species). Female genitalia with enlarged spinose sac in association with sclerotised colliculum 5
- Male genitalia without palmate setae on valves. Female genitalia without spinose lobe at colliculum 8

¹⁾ The nominate subspecies of *E. argyropeza* (Zeller, 1839) is European and therefore not included here.

5. Male genitalia with small three-pronged setae on dorsal surface of valves as in fig. 15. Hindwing of male without lance-shaped chitinous plate on costal margin. Female genitalia with equal signa, thin colliculum and minute spines on ductus as in fig. 16. Larva makes ophistigmatonome on leaves of *Platanus occidentalis* with long linear tract and large blotch . . . *clemensella* (p. 55)
- Male genitalia with strongly palmate setae on dorsal surface of valves. Hindwing of male with lance-shaped chitinous plate on costal margin. Female genitalia not with above combination of characters 6
6. Male genitalia with strongly bilobed saccus; sharply pointed valves bearing palmate setae with shaft approximately equal to or shorter than digitate processes as in fig. 17c. Female genitalia with small signa, unequal in length and very small spicules on lobe associated with colliculum as in fig. 18. Externals occur in two forms as in figs. 54 and 55. Larva makes ophistigmatonome in leaves of *Quercus* sp. *similella* (p. 56)
- Male genitalia without strongly bilobed saccus; valves not sharply pointed and bearing palmate setae with shaft much longer than digitate processes. Female genitalia with signa approximately equal in length and large spicules on lobe associated with colliculum 7
7. Male genitalia variable, but as in fig. 19; some palmate setae on valves with shaft up to three times length of digitate processes. Female genitalia with signa short and narrow about half length of bursa copulatrix; short rows of spines on lobe associated with colliculum, as in fig. 20c. Externals in two forms as in figs. 56 and 57. Larva makes ophionome in *Corylus* sp. leaves *virgulae* (p. 59)
- Male genitalia as in fig. 13; palmate setae on valves with shaft approximately twice length of digitate processes. Female genitalia with long, broad signa extending almost full length and covering most of bursa copulatrix; very large single spines on the lobe associated with colliculum as in fig. 14c. Externals as in fig. 53. Larva makes ophistigmatonome in leaves of *Platanus* *platanella* (p. 51)
8. Male genitalia with long triangular pseuduncus tapering to point; aedeagus as in fig. 4 or 21. Female genitalia never with spiculate lobe associated with colliculum 9
- Male genitalia with pseuduncus not triangular and rounded at least terminally. Female genitalia with spiculate lobe associated with colliculum 10
9. Male genitalia with dorsal arms of transtillae extending beyond saccus and comparatively small anellar projections; as in fig. 21. Female genitalia with thickened ring of colliculum and relatively long signa; as in fig. 22. Externals as in fig. 43. Larva forms stigmatonome on *Betula* sp. . . *lindquisti* (p. 61)
- Male genitalia with dorsal arms of transtillae broad and short, not extending beyond saccus; large anellar projections; as in fig. 4. Female genitalia with thin ring of colliculum and short signa; as in fig. 5. A petiole gall former on *Populus* sp. *popullella* (p. 41)
10. Male genitalia with small valves only about half length of capsule; anellus with bifurcate spines totalling more than six, as in fig. 11. Female genitalia with large single or double spines on spiculate lobe; signa broad and short; as in fig. 12. Externals as in fig. 52. Larva makes ophistigmatonome on *Rosa* sp.

- *marmaropa* (p. 49)
- Male genitalia usually with valves larger than half capsule length; anellus with four spines. Female genitalia with spiculate lobe not as above; signa long 11
11. Male genitalia with large broad pseuduncus and anellus with four large spines as in fig. 7b. Female genitalia with broad signa tapering distally as in fig. 8. Externals as in fig. 44. Larva is probably a petiole gall-former on *Populus* sp. *canutus* (p. 45)
- Genitalia not as above 12
12. Male genitalia with highly characteristic pseuduncus and shape of anellar spines and valves; as in fig. 9. Female genitalia with long narrow signa and large spines on spiculate lobe of colliculum; as in fig. 10. Externals as in fig. 51. Larva makes ophistigmatonome on *Carya* sp. *trinotata* (p. 46)
- Males non-existent. Parthenogenetic females with genitalia as in fig. 6. Larva mines first in petiole and then makes stigmatonome in lamina of *Populus* sp. *argyropeza downesi* (p. 45)
13. Male genitalia with not more than four large, simple spines near phallotreme; valves markedly incised along inner margin. Female genitalia without any thickening or sclerotisation at colliculum; apophyses usually not markedly different in length 14
- Male genitalia with more than four spines near phallotreme; valves not markedly incised. Female genitalia with colliculum thickened; posterior apophyses usually markedly longer than anteriores 16
14. Male genitalia with saccus strongly concave; anterior arms of valves long; aedeagus with thickened circular band of cornuti; as in fig. 35. Female not known *acanthella* (p. 75)
- Male genitalia not with above combination of characters. Female genitalia as in fig. 24 or 27 15
15. Forewings mottled, indistinct fascia, dull. Male genitalia with valves extending as far as, or further than, extremity of pseuduncus; dorsal arms of transtillae short as in fig. 26. Female genitalia as in fig. 27. Larva makes ophistigmatonome in leaves of *Ulmus* sp. *ulmella* (p. 65)
- Forewing with distinct fasciae, shining silver as in fig. 49. Male genitalia with valves not extending beyond pseuduncus; dorsal arms of transtillae reaching extremity of capsule as in fig. 23. Female genitalia as in fig. 24. Larva makes ophistigmatonome in *Rubus* sp. leaves *rubifoliella* (p. 63)
16. Forewings marked with four small silver patches as in fig. 48. Male genitalia with valves extending well beyond pseuduncus; crown of thorn-like spines present near phallotreme as well as large anellar spines; as in fig. 31. Female genitalia with simple circular thickening at colliculum. Anterior apophyses broad and unusually long reaching as far as posteriores as in fig. 32. Larva makes ophionome with blotch later, in leaves of *Ostrya*, *Carpinus*, *Corylus* and *Betula* sp. *quadrinotata* (p. 70)
- Male genitalia with valves not extending far beyond pseuduncus; anellar spines and cornuti characteristic, similar to figs. 33 and 37. Female genitalia with complex thickened folds at colliculum. Anterior apophyses always much shorter than posteriores 17

17. Male genitalia with valves just reaching end of pseuduncus; as in fig. 37. Female genitalia as in fig. 38 18
 — Genitalia not as above 19
18. Larva mines the bark of *Quercus* sp. Externals as in fig. 61
 *heinrichi* (p. 78)
 — Larva makes galls on twigs of *Castanea*. Externals as in fig. 62
 *castaneae* (p. 80)
19. Male genitalia without swellings or characteristic knobs on inner surface of valves; as in fig. 36. Externals as in fig. 55. Female not known
 *piperella* (p. 77)
 — Male genitalia with characteristic knobs on inner surface of valves. Female genitalia with spicules on colliculum 20

TABLE FOR THE IDENTIFICATION OF *ECTOEDEMA* SPECIES FROM HOST PLANTS AND DAMAGE

<i>Ectoedemia</i> species	host genus	host species	site of larval damage	form of larval damage	probable No. of generations	Type locality
<i>populella</i>	<i>Populus</i>	<i>tremuloides</i> <i>grandidentata</i>	petioles	galls	1	—
<i>argyropeza</i> <i>downesi</i>	<i>Populus</i>	<i>tremuloides</i> <i>?grandidentata</i>	1st petioles 2nd lamina	ophionome stigmatonome	1, ♀ only	Ontario
<i>canutus</i>	<i>Populus</i>	<i>balsamifera</i>	petioles	galls	1?	Ontario
<i>trinotata</i>	<i>Carya</i>	<i>cordiformis</i>	lamina	ophistigmatonome	2	Ohio
<i>marmaropa</i>	<i>Rosa</i>	<i>woodsii</i>	lamina	ophistigmatonome	—	Utah
<i>platanella</i>	<i>Platanus</i>	<i>occidentalis</i>	lamina	ophistigmatonome	3	—
<i>clemensella</i>	<i>Platanus</i>	<i>occidentalis</i>	lamina	ophistigmatonome	3	Kentucky
<i>similella</i>	<i>Quercus</i>	<i>palustris</i> <i>rubra</i>	lamina	ophistigmatonome	up to 3	Ohio
<i>virgulae</i>	<i>Corylus</i>	<i>americana</i>	lamina	ophionome	2	Ohio
<i>lindquisti</i>	<i>Betula</i>	<i>papyrifera</i> <i>lutea</i>	lamina	stigmatonome	1	Ontario
<i>rubifoliella</i>	<i>Rubus</i>	sp.	lamina	ophistigmatonome	2	Ohio
<i>ulmella</i>	<i>Ulmus</i>	<i>rubra</i> <i>americana</i> <i>racemosa</i>	lamina	ophistigmatonome	2	Ohio
<i>nyssaefoliella</i>	<i>Nyssa</i>	<i>sylvatica</i>	lamina	ophistigmatonome	2 or 3	Ohio
<i>quadrinotata</i>	<i>Carpinus</i> <i>Corylus</i> <i>Ostrya</i> <i>Betula</i>	<i>caroliniana</i> <i>americana</i> <i>virginiana</i> <i>lutea</i>	lamina	ophistigmatonome	2	Ohio
<i>obrutella</i>	<i>Quercus?</i>	sp.	bark?	—	—	Texas
<i>acanthella</i>	—	—	bark?	—	—	New Jersey
<i>piperella</i>	—	—	bark?	—	—	Arkansas
<i>heinrichi</i>	<i>Quercus</i>	<i>palustris</i>	bark, twigs	spiral ophionome	1	Virginia
<i>castaneae</i>	<i>Castanea</i>	sp.	bark, twigs	galls	2 or 3	Virginia
<i>phleophaga</i>	<i>Castanea</i>	<i>dentata</i>	bark, cambium	ophionome	1	Virginia
<i>chlorantis</i>	—	—	bark?	—	—	Ontario
<i>mesoloba</i>	—	—	bark?	—	—	Florida

For *Amelanchier* see *nyssaefoliella* description.

20. Male genitalia with simple rounded knob on inner side of valves; valves not reaching beyond pseuduncus; as in fig. 42. Externals as in fig. 50. Female not known *mesoloba* (p. 85)
- Male genitalia different from above and valves extending beyond pseuduncus. Only females known in one species 21
21. Genitalia as in figs. 33 and 34. Male genitalia with three small knobs on inner side of valves. Anterior arms of valves long extending beyond capsule. Externals as in fig. 47 *obrutella* (p. 72)
- Genitalia and externals not as above 22
22. Genitalia as in figs. 39 and 40. Male genitalia with characteristic knobs on inner side of valves. Dorsal arms of transtillae short. Female genitalia with comparatively simple ductus bursae. Externals in fig. 63. Larva makes a bark ophionome in *Castanea* sp. *phleophaga* (p. 81)
- Female genitalia as in fig. 41. Complex thickening in ductus bursae. Externals as in fig. 46. Male not known *chlorantis* (p. 84)

THE POPULELLA GROUP

The North American *Ectoedemia* can be divided into four species groups. The *populella* group contains the first five species. All males have a pointed pseuduncus except *argyropeza downesi* where males are not known to occur. They lack the multi-branched setae on the inner sides of the valves found in the *platanella* group. All females have a sclerotised ring-shaped colliculum and associated denticulate patch. *E. lindquisti* could belong in this group but it does not have the same characteristic anellar processes and has perhaps more affinity with the *rubifoliella* group.

This group includes all the species which attack petioles: *populella*, *argyropeza* and probably *canutus*, as well as the leaf miners *trinotata* and *marmaropa*.

***Ectoedemia populella* Busck** (figs. 4, 5)

Ectoedemia populella Busck, 1907: 98.

Ectoedemia populella Busck; Braun, 1917: 197.

Ectoedemia populella Busck; Braun in Forbes, 1923: 83.

Ectoedemia populella Busck; McDunnough, 1939: 107 (no. 9783).

Ectoedemia populella Busck; Borkowski, 1972: 697.

Ectoedemia populella Busck; Wilkinson & Scoble, 1979: 74.

Description. — Fully described from Canada by Wilkinson & Scoble (1979).

Diagnosis. — Usually larger than the other members of the genus studied here and characterised by the cupreous reflections of forewings. Differs from *canutus* in the valves, which are shorter and broader, and the gnathos, which is not bifid laterally, in *populella*. The gall forming habit differentiates the larvae from those of *argyropeza* which produce more irregular callus tissue.

Distribution. — USA: — New York, New Hampshire, Massachusetts, Ohio (Braun). Canada: — Ontario, Manitoba.

Material examined. — In USNM —USA: New York, Monroe Co.; on *Populus*

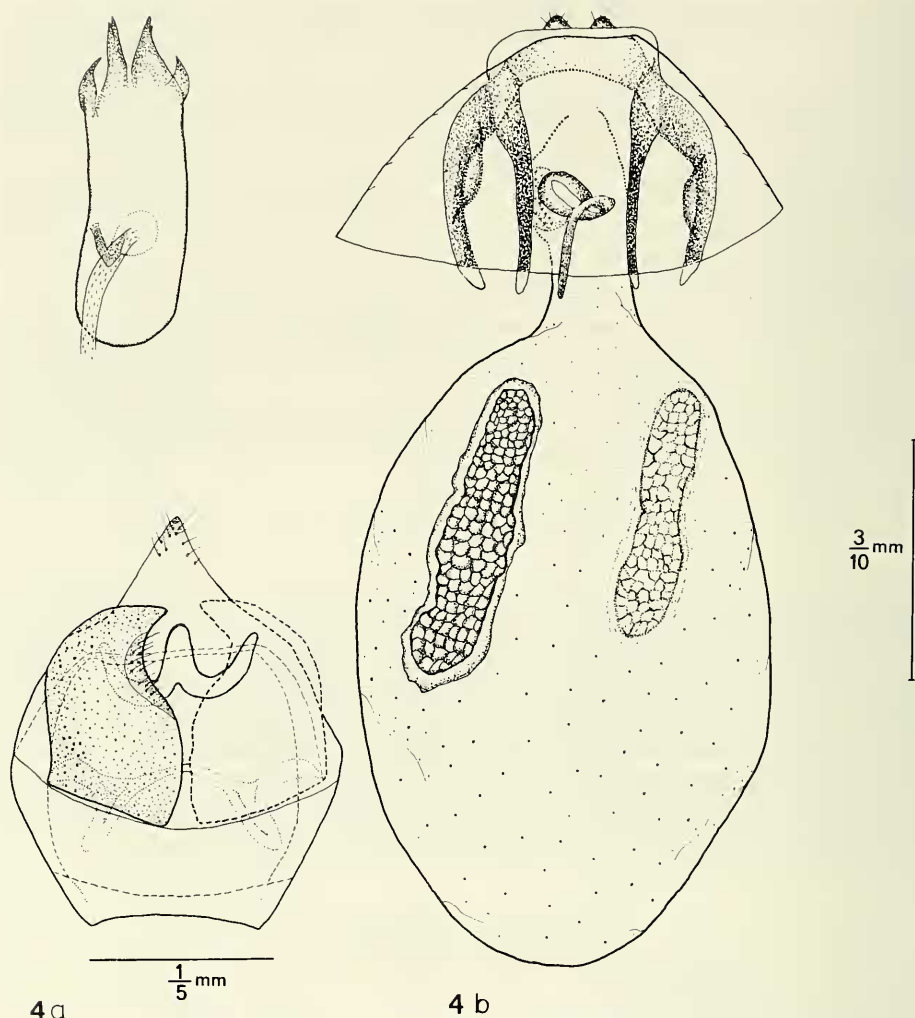


Fig. 4. *Ectoedemia populella* Busck, ♂ (a) and ♀ (b) genitalia.

sp.; 8 ♂, 2 ♀, 2 ex., 1—16.v.1948 (Kimball). "Awene, Man."; 1 ♀, 24.v.1921 (Criddle). In CNC — Canada: Ontario, Bells Corner; 2 ♀, 30.v.1965 (Sattler); Lake Erie, Cultus; on *Populus tremuloides*; 1 ♂, 1.iii.1962; La Passe; on *Populus* sp.; 1 ♂, 10.xii.1970; 1 ♂, 1.iii.1971 (Lewis); Minden, 1 ♂, 27.v.1931 (McDunnough). In SOO — Ontario, Bradford; on *Populus tremuloides*, 1 ♂, 2 ♀, 1 ex., 28.v.1970; on *Populus grandidentata*, 2 ♂, 5 ♀, 3 ex., 28.v.1970; Nestor Falls; on *Populus tremuloides*; 1 ♂, 11.ii.1963, 1 ♂, 7.iii.1963.

Galls examined: In FIS — Canada: Ontario, Bradford; several galls on *Populus grandidentata* preserved in alcohol; 16.vii.1969, 695—2125—01; Uxbridge; several galls on *Populus tremuloides* preserved in alcohol; 11.ix.1969, 675—4171—01.

Syntypes. 1 ♂, 1 ♀, have also been examined from the collection in the Transvaal museum. However a lectotype is not here designated. This will be done

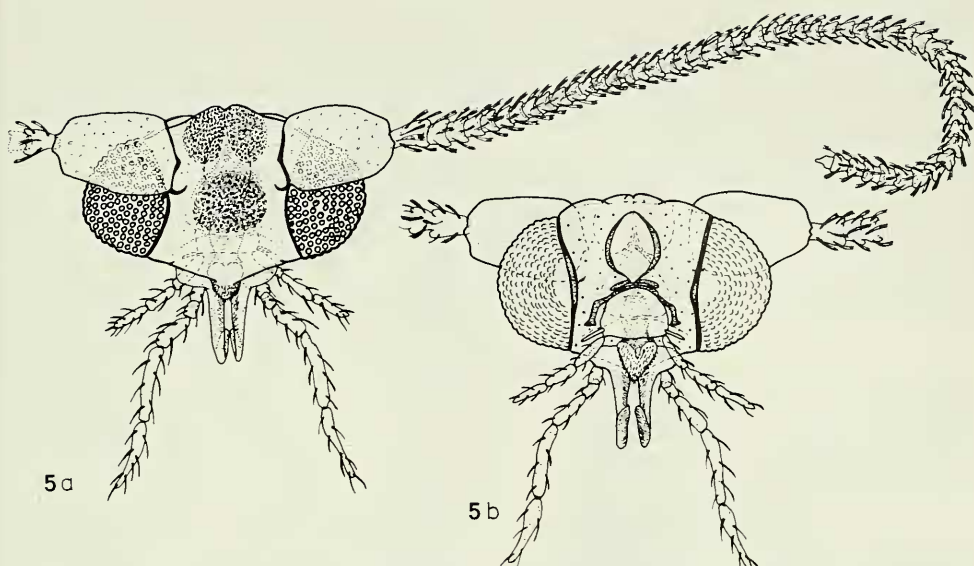


Fig. 5. *Ectoedemia populella* Busck, head, anterior (a) and posterior (b) view ($\times 70$).

in "The Moths of North America north of Mexico" from the type-series in the USNM.

Biology. — The larvae form galls on the leaf petioles of *Populus tremuloides* and *P. grandidentata*. These are swellings situated close to the lamina. The larvae mature in October and the imagines emerge in May of the following year (Busck, 1907; Braun, 1917). The specimens in the CNC that emerged earlier than this were probably "forced" in the laboratory.

Voltinism. Univoltine in both Canada and the U.S.A.

***Ectoedemia argyropeza* (Zeller)** (fig. 6)

Lyonetia argyropeza Zeller, 1839: 215.

Nepticula argyropeza (Zeller); Zeller, 1848: 320.

Nepticula argyropeza (Zeller); Petersen, 1930: 78.

Nepticula argyropeza (Zeller); Hering, 1951: 232.

Nepticula turbidella Zeller *sensu* Herrich-Schäffer, 1853: 357; Downes, 1968: 1078.

Dechtria argyropeza (Zeller); Beirne, 1945: 205.

Dechtria argyropeza (Zeller); Emmet, 1971: 242.

Dechtria argyropeza (Zeller); Borkowski, 1972: 698.

Stigmella argyropeza (Zeller); Borkowski, 1969: 107.

Stigmella (sic) *turbidella* (Zeller) *sensu* Herrich-Schäffer, 1853: 357; Cochaux, 1969: 12.

Trifurcula (*Ectoedemia*) *argyropeza* (Zeller) *sensu* Johansson, 1971: 245.

Ectoedemia argyropeza (Zeller); Emmet, 1976: 189.

Ectoedemia argyropeza (Zeller); Wilkinson & Scoble, 1979: 77.

Description. — Fully described from Canada by Wilkinson & Scoble (1979) and is regarded as being represented by two subspecies. The female genitalia of the subordinate subspecies are shown in fig. 6.



6

Fig. 6. *Ectoedemia argyropeza* (Zeller), ♀ genitalia.

Diagnosis. — Differs from *canutus* in the forewing ground colour, which is generally darker and less irrorate in *argyropeza*. The wider and less pointed ovipositor distinguishes the genitalia from those of *canutus*.

Discussion. — Closely related to the following species, *canutus*, in both externals and genitalia.

***Ectoedemia argyropeza argyropeza* (Zeller)**

Diagnosis. — Differs from the subordinate subspecies in the paler forewing ground colour. Only known in Europe whilst *downesi* is North American.

Material examined. — ♀ Lectotype: "Gross Glogau, Silesia, Zeller 183: 101291,

Zeller Collection Walsingham Collection 1910—427, 101291, *Argyropeza* Zeller 1839: 215. *Lyonetia A. Bucculatrix* Isis 1839: 215"; in BM (NH).

Other specimens: In BM (NH) —Locality as lectotype; 1 ♀, 22.v.1853 (Zeller); Walsingham Coll. ex Zeller Coll., 1910—427; 101289.

***Ectoedemia argyropeza downesi* Wilkinson & Scoble**

Ectoedemia argyropeza downesi Wilkinson & Scoble, 1979: 80.

Diagnosis. — Differs from the nominate subspecies in the ground colour of the forewings which are grey and heavily irrorate with purplish brown scales distally. Occurs only as parthenogenetic females.

Distribution. — Canada: — Ontario, Quebec.

Material examined. — ♀ Holotype: Canada: "Ontario, Ottawa"; on *Populus tremuloides*; 29.v.1969 (Downes); in CNC. Paratypes: In CNC — data as holotype; 12 ♀, 29.v.1969, 5 ♀, 28.v.1968, 2 ♀, 31.v.1968, 4 ♀, 4.vi.1968, 2 ♀, 7.vi.1968 (Downes). Ontario, Ottawa; on *Populus* sp.; 20 ♀, 6.v.1941 (Freeman); Ste. Anne de Bellevue, P.Q., Morgan Arboretum; 4 ♀, 1.vi.1969 (Sheppard).

Biology. — Egg. Laid on the petioles of *Populus tremuloides* and *P. grandidentata*. The number of eggs per leaf depends on leaf size and the position of the leaf on the tree: eggs are more abundant on leaves at lower levels.

Mine. Begins as a petiole mine and later becomes of stigmatonome in the leaf blade. Whilst a certain amount of callus tissue is formed in the petiole of *Populus tremuloides*, in *P. grandidentata* this may, apparently, block the mine, preventing the larvae from developing: the larvae seldom reach maturity on this host. A green zone extends along the mined portions of the leaf-blade, even after the leaf has turned yellow and fallen to the ground ("green-islands" of Hering).

Larva. Remains in the mine until after leaf fall in late October and early November. Over-winters in ground litter or soil in cocoon.

Pupation. Occurs in early spring.

Voltinism. One generation per year.

Other notes. Cochaux (1969: 12) suggests that the very high populations of this species may be due to the parthenogenetic reproduction.

***Ectoedemia canutus* Wilkinson & Scoble**

(figs. 7, 8, 44)

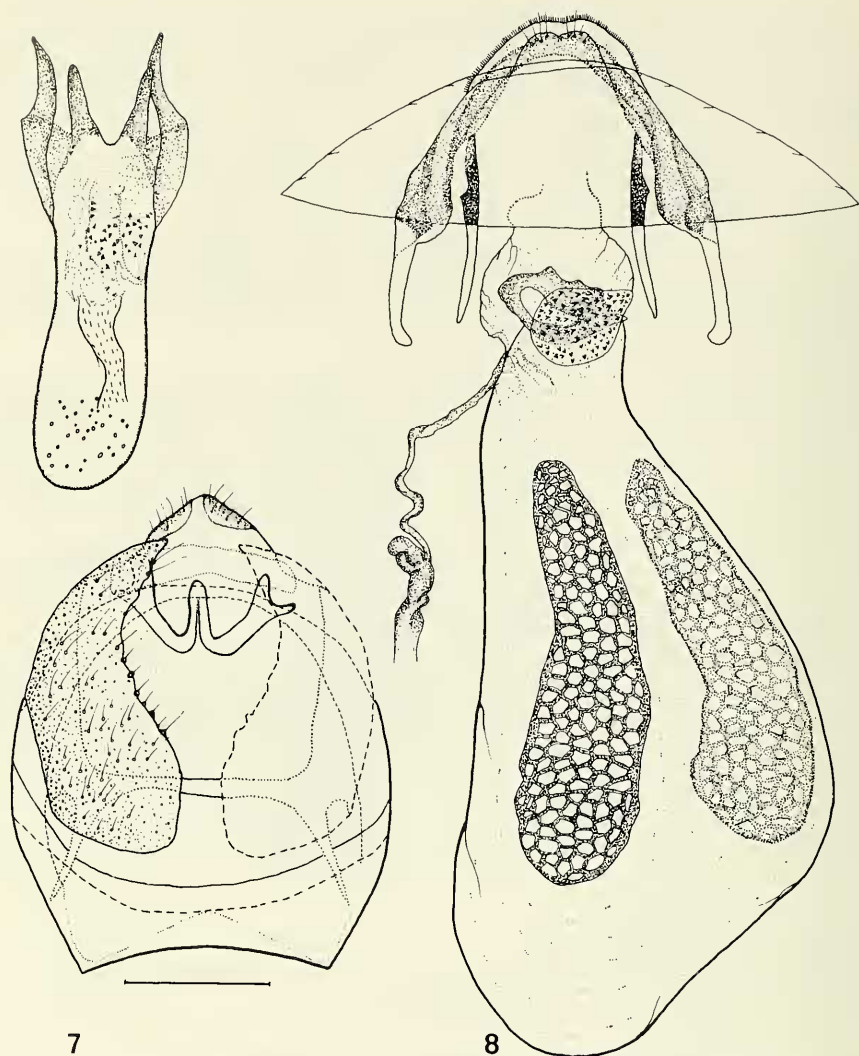
Ectoedemia canutus Wilkinson & Scoble, 1979: 81.

Description. — Fully described by Wilkinson & Scoble (1979).

Diagnosis. — Generally darker than *argyropeza argyropeza* and more uniformly irrorate than *argyropeza downesi*. The valves of the male *canutus* are larger and narrower than in *populella*. It also differs in the bifid nature of the gnathos.

Distribution. — USA: — California. Canada: — Ontario.

Material examined. — ♂ Holotype: Canada: Ontario, Angus; on *Populus balsamifera*; 4.iii.1969, 68.5.3397.01; SOO no. 9; in SOO. Paratypes: In SOO — Canada: data as in Holotype; 6 ♂, 3 ♀, 3—11.iii.1969; 5 ♂, 1 ♀, 2 ex., 28.v.1970, 705.0074.01.



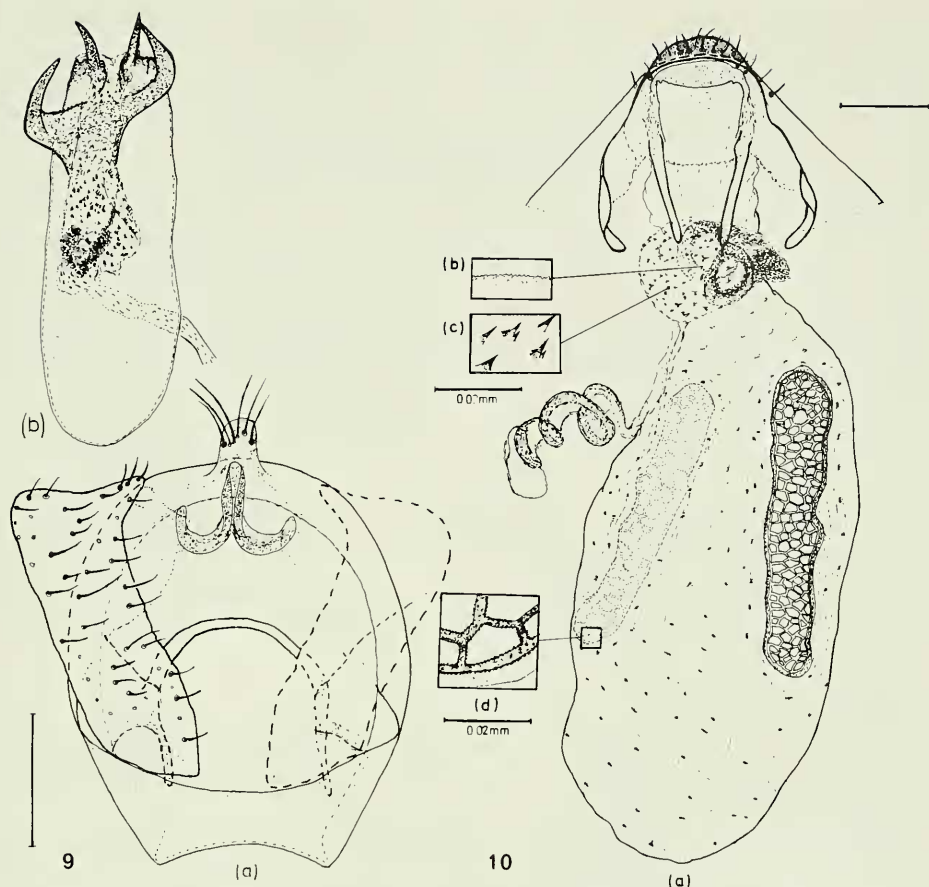
Figs. 7, 8. *Ectoedemia canutus* Wilkinson & Scoble, ♂ (7) and ♀ (8) genitalia.

Other material. — USA: 4 ♂, 2 ♀, California, Los Angeles Co., Big Rock Wash., near Lovejoy Buttes, T6N R9W Sec 30, elev 2770', 31.iii.1972 (Donahue).

Biology. — Probably a gall former on the petioles of *Populus balsamifera*. Galls examined: There are several galls on petioles, preserved in alcohol, which are indistinguishable from those of *populella*. The host and locality suggest that they may belong to *canutus*. In SOO — Canada: Ontario, Angus; on *Populus balsamifera*; 3.ix.1968 (Bowser).

***Ectoedemia trinotata* (Braun) comb. nov.**
(figs. 9, 10, 51, 66)

Nepticula trinotata Braun, 1914: 18.



Figs. 9, 10. *Ectoedemia trinotata* (Braun), ♂ (9) and ♀ (10) genitalia.

Nepticula trinotata Braun; Braun, 1917: 169.

Nepticula trinotata Braun; Braun in Forbes, 1923: 87.

Nepticula trinotata Braun; McDunnough, 1939: 107 (no. 9723).

Description. — External features: ♂. Head: palps whitish; antennae dark brown; tuft on front of head ochreous, vertex paler; eye-caps shining white; collar off-white. Thorax very dark grey-brown with purple and blue reflections. Abdomen grey, shining metallic grey beneath. Forewings: ground colour of dorsal surface very dark brown, basal third with purple reflections, apical two thirds irrorate, with base of each scale greyish; fringe whitish, shining silver, with apical band of dark brown wing scales; small diffuse antemedial spot on costal margin which is occasionally eclipsed by greyish reflections when viewed from certain angles, followed by two distinct postmedial spots, shining silver, one at each margin. Hindwings: ground colour and fringe brownish grey, shining metallic grey. Legs dark brown, shining metallic grey behind. Fig. 51.

Female. As ♂ except for a pair of external convex pockets ventro-medially placed on the fourth abdominal segment.

Wing expanse: ♂: 3.8—5.3 mm (6 specimens); ♀: 4.4—5.4 mm (7). Holotype: 5.0 mm.

Genitalia: ♂ (fig. 9). Pseuduncus with a single lobe as in fig. 9 (a). Gnathos: W-shaped as in fig. 9 (a) with long medial process; dorso-lateral arms short. Vinculum: lateral arms broad; ventral plate very narrow. Saccus approximately five times the width of the ventral plate, weakly bilobed. Valves not reaching beyond the pseuduncus, quadrate and with a triangular inner process, arising distally. Transtillae: an inverted U-shape as in fig. 9 (a); lateral arms broad and short; ventral arms narrow, reaching just beyond ventral plate; transverse bars fused to form a narrow arcuate strap. Aedeagus: regular in shape, approximately equal to length of the capsule; vesica with cornuti as many small denticles evenly distributed and with plate of minute papillae in the shape of figure eight; anellus comprising a pair of lateral spines and a pair of large canine tooth-like spines.

Female (fig. 10). Ductus bursae short with colliculum as a sclerotised double ring associated with a large lobe bearing scattered spicules as in fig. 10 (c). Accessory duct arising from area of dilation of the ductus, distally spiralled. Bursa copulatrix: very large and covered with small scallop-shaped chains of pectinations on striations of the bursa; signum double, comprising a pair of long cellular patches, equal in area as in figs. 10 (a) and 10 (d). Anterior apophyses long and broad. Posterior apophyses straight and broad, equal in length to the anteriores.

Host plant: *Carya cordiformis* (Hickory).

Mine: An upper surface ophistigmatonome.

Diagnosis. — Easily differentiated from other members of the genus in this study by the forewing markings, the lobe of the pseuduncus and the form of the transtillae. The mine differs from the serpentine tract produced by *Stigmella juglandifoliella* (Clemens) also found on *Carya* spp.

Discussion. — Although the externals resemble those of *quadrinotata* there is no similarity in the genitalia. The form of the colliculum in the female relates this species to several members of the genus.

Distribution. — USA: — Ohio, Arkansas, Illinois.

Material examined. — ♀ Holotype: USA: "B.499; Cincinnati, Ohio, Annette F. Braun, i, 3.viii.1913; Type Collection of Annette F. Braun; *Nepticula trinotata* Braun Type"; on *Carya* sp.; slide no. 144-PJN; in ANS. Paratypes: In ANS data as holotype; 3 ♀, 1,2,3.viii.1913, 1 ♂, 1 ex., 31.vii.1913, 2 ♂, 8,11.viii.1913, B.499 (Braun). In USNM — same data as Holotype: 2 ♀, 6,15.viii.1913, B.499 (Braun); slide nos: 145-PJN, 146-PJN, CNC 3480.

Other specimens: In ANS — USA: Ohio, Cincinnati; on *Carya* sp.; 1 ♀, 15.viii.1914, 1 ♂, 17.vi.1917, 1 ♂, 1 ♀, 10.vii.1917, B.499 (Braun). In USNM — Arkansas, Washington County; 1 ♂, 10.vii.1966 (Hodges). Illinois, Putnam County; 2 ♂, 1 ♀, 1 ex., 21.vii.1962, 1.vi.1963, 6.viii.1964, 12.vii.1965.

Mines examined: In ANS — USA: Ohio, West Fork Woods; 4 mines on *Carya* sp.; 15.vii.1909, B.499 (Braun).

Biology. — Egg. Laid on the upper or lower surface, usually near a vein.

Mine. At first a very narrow, much contorted linear mine which rapidly enlarges into an extensive blotch. The frass is scattered throughout the mine (fig. 66).

Larva. Emerges from the mine on the upper surface of the leaf.

Pupa. Cocoon pale brown in colour.

Voltinism. Bivoltine in Ohio, adults emerging from the overwintering generation in June and from the other generation in late July and early August.

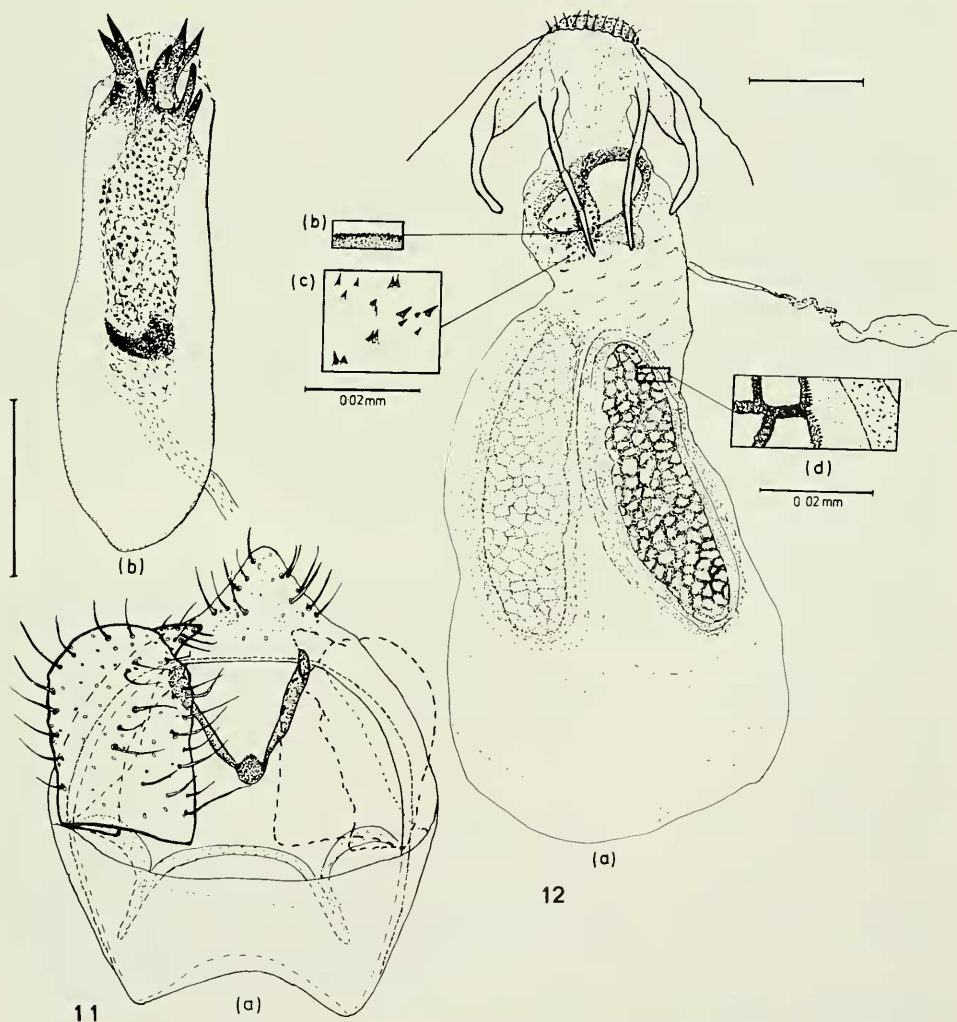
***Ectoedemia marmaropa* (Braun) comb.n.**

(figs. 11, 12, 52, 67)

Nepticula marmaropa Braun, 1925: 225.

Nepticula marmaropa Braun; McDunnough, 1939: 107 (no. 9778).

Description. — External features: ♂. Head: palps buff-grey; antennae grey; tuft on front of head ochreous, vertex darker; eye-caps shining white; collar pale ochreous. Thorax dark brown with gold and bronze reflections. Abdomen brown with



Figs. 11, 12. *Ectoedemia marmaropa* (Braun), ♂ (11) and ♀ (12) genitalia.

gold reflections above, shining metallic grey beneath. Forewings: ground colour of dorsal surface dark brown with bronze and gold reflections, becoming irrorate distally, each scale being darker at the tip; fringe grey, shining silver at apex, with an apical band of dark brown wing scales; basal patch extending to one-fifth, dusted with grey, followed by a single postmedial fascia, convex and shining silver. Hindwings: ground colour and fringe brownish grey, shining metallic grey. Legs dark brownish with silver reflections on both surfaces. Fig. 52.

Female. As ♂ except for a pair of external convex pockets ventro-medially placed on the fourth abdominal segment.

Wing expanse: ♀: 4.2—4.4 mm (3 specimens). Holotype ♂: 4.0 mm.

Genitalia: ♂ (fig. 11). Pseuduncus with a single tapering lobe, rounded terminally. Gnathos: W-shaped as in fig. 11 (a); transverse ventral plate with a short central boss; dorso-lateral arms long and thin. Vinculum: lateral arms broad; ventral plate narrow. Saccus approximately twice width of ventral plate, bilobed. Valves reach not much further than base of pseuduncus, quadrate with a short, broad style and very broad cuiller. Transtillae: broadly W-shaped as in fig. 11 (a); lateral arms narrow; ventral arms straight, reaching beyond the ventral plate; transverse bars fused to form a narrow strap. Aedeagus: flask-shaped, just greater than length of the capsule; vesica with cornuti as many small denticles evenly distributed and with a pair of large digitate cornuti at the phallotreme, also with a cup-shaped plate of minute papillae; anellus comprising a pair of large plates with bifurcate spines.

Female (fig. 12). Ductus bursae short with colliculum as a sclerotised double ring associated with a small lobe bearing scattered spicules as in fig. 12 (c). Accessory duct arising from dilation of the ductus, spiral medially. Bursa copulatrix: very large, covered with short chains of pectinations proximally; signum double, comprising a pair of equal, ovate cellular patches as in figs 12 (a) and 12 (d). Anterior apophyses long and arcuate. Posterior apophyses straight and narrow reaching beyond the anteriores.

Host plant: *Rosa woodsii*.

Mine: An upper surface ophistigmatonome.

Diagnosis. — The lustrous basal patch of the forewings separates this species from any other in the genus with a single fascia. Resembles *lindquisti* in the overall form of the male genitalia but differs in the nature of the valves and the more complex anellar processes in *marmaropa*. The aedeagus is larger than that of *lindquisti*.

Discussion. — Related to several members of the genus in the form of the female genitalia.

Distribution. — USA: — Utah, Wyoming. Ohio?

Material examined. — ♂ Holotype: USA: "B.1191; Cache Co., Utah, i.23.iv.1925. Annette F. Braun; Type Collection of Annette F. Braun; *Nepticula marmaropa* Braun Type"; on *Rosa woodsii*; slide no. 131-PJN; in ANS. Paratypes: In ANS data as Holotype; 2 ♀, 3, 17.iv.1925 (Braun); slide nos: 132-PJN, 133-PJN.

Other Specimens: In ANS — USA: Wyoming, Phelps Lake, Grand Teton National Park; 1 ♀, 17.v.1935, B.1462 (Braun).

Mines Examined: In ANS — USA: Ohio; 2 mines on *Rosa woodsii*; no date, B.1191 (Braun).

Biology. — Egg. Laid on the lower surface of the leaf and, in both cases observed, next to the midrib.

Host. The specimen from Wyoming bears the A. F. Braun breeding number B.1462; the record and the material cannot be located for identification of the host plant.

Mine. Begins as a very narrow linear mine but abruptly enlarges into a blotch which may consume half the area of the leaf. The frass is scattered throughout the blotch (fig. 67).

Larva. Emerges on the upper surface of the leaf.

Pupa. Cocoon at first bluish green, later turning dark brown in colour.

THE PLATANELLA GROUP

The following four species — *platanella*, *clemensella*, *virgulae* and *similella* — can be separated to form a discrete group, when this is seen to be an advantage.

The males have the same tapering pseuduncus and W-shaped gnathos of the last group; the aedeagus has very pronounced anellar lobes. The most notable character is the presence of multi-branched setae on the inner surface of the valves — more weakly developed in *clemensella*.

The colliculum is present as a single or double sclerotised ring in females.

Externally there is a lance-shaped chitinous plate along the fore-edge of the hind wing in the males, except in *clemensella*. Another minor feature is the forewing marking. All have a biconcave fascia reduced in some to a pair of marginal streaks. All are leaf-miners.

***Ectoedemia platanella* (Clemens)**

(figs. 13, 14, 53, 68)

Nepticula platanella Clemens, 1861: 83.

Nepticula platanella Clemens; Clemens, 1862a: 133.

Nepticula plantanella (sic) Clemens; Clemens, 1862b: 149, 150.

Nepticula platanella Clemens; Clemens, 1865: 146.

Nepticula platanella Clemens; Clemens in Stainton, 1872: 173, 183, 192.

Nepticula platanella Clemens; Chambers, 1873: 125.

Nepticula platanella Clemens; Chambers in Hayden, 1878b: 158.

Nepticula platanella Clemens; Dyar, 1903: 546.

Nepticula platanella Clemens; Busck, 1903: 209.

Nepticula platanella Clemens; Braun, 1917: 187.

Nepticula platanella Clemens; Braun in Forbes, 1923: 92.

Nepticula platanella Clemens; McDunnough, 1939: 107 (no. 9760).

Ectoedemia platanella (Clemens); Wilkinson & Scoble, 1979: 89.

Nepticula maximella Chambers, 1873: 126 (syn. by Braun, 1917: 187).

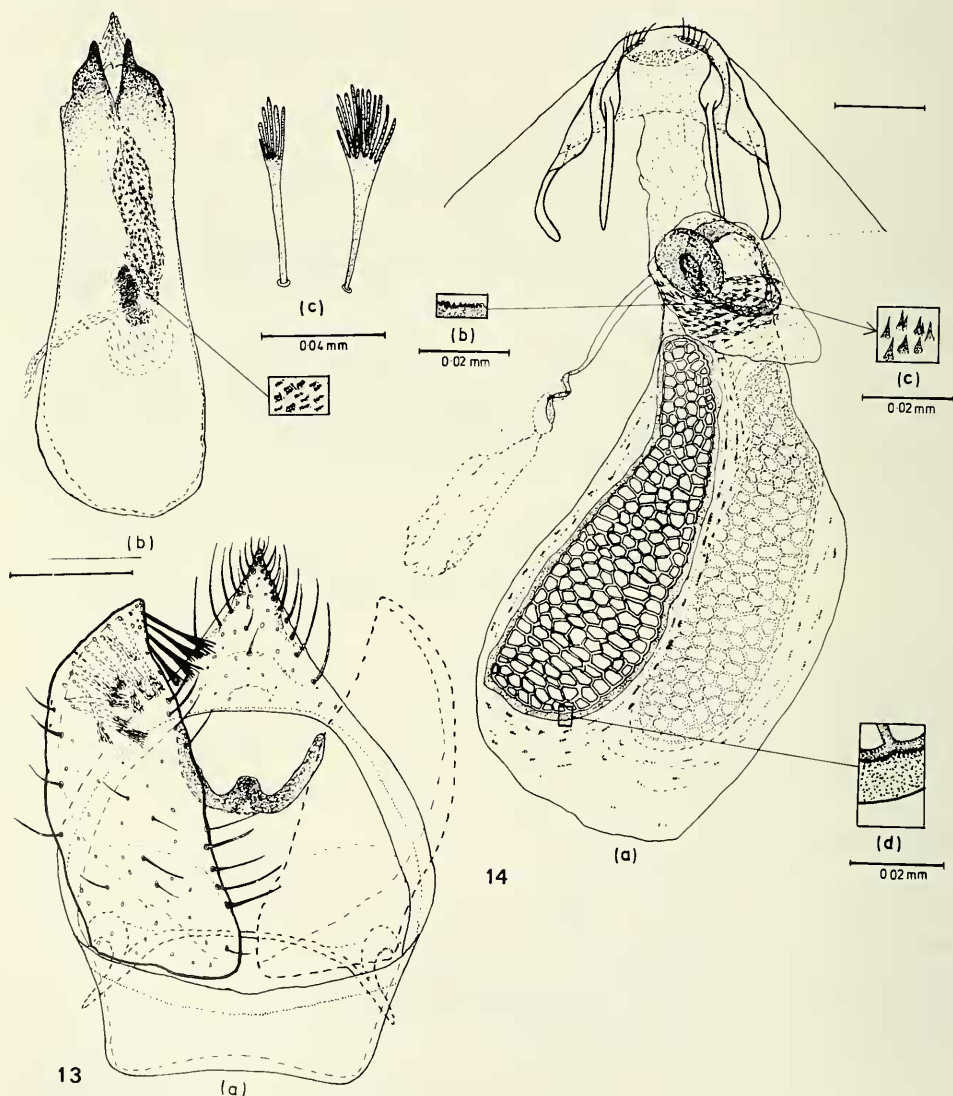
Nepticula maximella Chambers; Chambers in Hayden, 1878b: 158.

Nepticula maximella Chambers; Dyar, 1903: 546.

Description. — External features: ♂. Head: palps buff; antennae dark brown; tuft on front of head pale ochreous, vertex darker; eye-caps shining white; collar

pale ochreous. Thorax and abdomen dark greyish brown. Forewings: ground colour of dorsal surface dark brown with bronze lustre; fringe whitish, with an apical band of dark brown wing-scales; a pair of white, medial streaks marginally, which are occasionally linked in the middle by a few white scales to form a complete fascia. Hindwings: ground colour and fringe pale grey; a lance-shaped chitinous plate extends along the fore edge to the middle of the costa. Legs buff, with areas of dark brown. Fig. 53.

Female. As ♂ except that chitinous plate of hindwings is absent. With a pair of convex, external pockets ventro-medially placed on the fourth abdominal segment.



Figs. 13, 14. *Ectoedemia platanella* (Clemens), ♂ (13) and ♀ (14) genitalia.

Wing expanse: ♂: 4.0—6.8 mm (25 specimens); ♀: 3.6—6.8 mm (23). Neotype: 6.0 mm.

Genitalia: ♂ (fig. 13). Pseuduncus with a single tapering lobe. Gnathos: W-shaped as in fig. 13 (a); transverse ventral plate with broad central boss; dorso-lateral arms long. Vinculum: lateral arms narrow; ventral plate narrow. Saccus more than twice the width of the ventral plate and weakly bilobed. Valves: not reaching beyond the pseuduncus, tapering slightly; with terminally digitate setae on the dorsal surface distally as in fig. 13 (c). Transtillae: with short, narrow lateral arms; ventral arms reaching beyond the ventral plate; transverse bars fused to form a continuous narrow strap. Aedeagus: approximately equal to length of the capsule, regular in width; vesica with cornuti as many small denticles evenly distributed and with a comma-shaped plate of minute papillae; anellus comprising two pairs of simple spines as in fig. 13 (b).

Female (fig. 14). Ductus bursae long, colliculum as a sclerotised double ring ring with serrate inner margin, as in fig. 14 (b), and with associated lobe bearing scattered spicules as in fig. 14 (c). Accessory duct arising from area of dilation of the ductus, spiral distally. Bursa copulatrix very large and covered with small scallop-shaped chains of pectinations on striations of the bursa; signum double, comprising a pair of long reticulate patches, equal in area as in figs 14 (a) and (d). Anterior apophyses long and broad. Posterior apophyses straight and narrow, equal in length to the anteriores.

Host plant: *Platanus occidentalis*.

Mine: An upper surface ophistigmatonome.

Diagnosis. — Usually larger and browner than *clemensella* and the males have the hindwing scale which is absent in *clemensella*. The linear portion of the mine is longer in *clemensella* and the enlargement into the blotch more gradual than in *platanella*. The male genitalia differ in the nature of the saccus, which is markedly bilobed, and the scales of the valves, which are shorter and less furcate, in *clemensella*. The female genitalia may be separated from those of *similella* and *virgulae* by the spines of the accessory sac, which are large and single, in *platanella*.

Discussion. — Clemens (1861: 83) originally described this species from mines found on the "Button-Wood Tree or Sycamore". In 1862 he described an adult caught at light which he gave the same name and labelled as type. The original mine(s) described actually constitute the type(s) but they have never been mentioned in print and are no longer extant. To resolve this problem a neotype is here designated. It is the specimen described by Clemens and also Busck (1903: 209). Chambers (1873: 126) described adults which he named *maximella* and associated them with a mine earlier described by Clemens (1862b: 149) as Sycamore miner no. 3 and thought to be the product of a different species. In spite of this, Braun (1917: 187) later synonymised *maximella* with *platanella* although she gave no reasons. The mine of *maximella* is characteristic in the quadrate nature of the terminal blotch as opposed to the round blotch of *platanella* material. Examination of the genitalia shows that the male syntype of *maximella* lacks the bifurcate anellar process and the saccus is less markedly bilobed than in examples of *platanella*. However, this preparation is distorted so we do not regard the differences observed to be sufficient to withdraw *maximella* from synonymy at this stage.

Distribution. — USA: — Ohio, New Jersey, Washington D.C., Pennsylvania, Kentucky, Massachusetts, Florida, Alabama. Canada: — Ontario.

Material examined. — Designated as neotype the ♀ examined by Busck (1903): USA: "Type no. 7494, *Nepticula platanella* B. Clemens, Specimen no. 118, A.B. 1903"; slide no. CNC 3464; in ANS. Syntypes of *maximella*: 1 ♂, "2) *Nepticula maximella* Cham."; Type no. 525 USNM; slide no. CNC 3477; 1 ♀, "2) Cham. Type"; slide no. CNC 3502; in USNM.

Other Specimens: In ANS — USA: Ohio, Cincinnati; on *Platanus* sp.; 1 ♀, 12.vii.1909, 2 ♂, 13.vii.1909, 1 ♂, 29.vii.1909, 1 ♀, 4.vii.1911, 1 ♂, 1 ♀, 5.vii.1911, 1 ♀, 29.vii.1913, B.348 (Braun); 1 ♀, 30.vii.1903 (Braun). Ohio, Cincinnati; 5 ♂, 2 ♀, 27.vi.1916 (Braun); 1 ♂, "Lot 72", (Heimbach). No locality data; 3 ♀ 1, "2, *Nepticula maximella* Cham = *N. platanella* Clem". In USNM — Ohio, Cincinnati; on *Platanus* sp.; 1 ♀, 10.vii.1909, B.348 (Braun). Ohio, Cincinnati; 1 ♂, 31.vii.1903, 1 ♂, 4.viii.1903, 1 ♀, 22.v.1906, 5 ♂, 1 ♀, 6 ex., 27.vi.1916 (Braun). No locality data; on *Platanus* sp.; 1 ♂, 17.vi.1885, 1 ♀, 5.v.1885 (Murfeldt); 1 ♂, "1) *N. platanella* Clem. Ch."; 1 ♀, 5.vi.1885 (Fernald Coll.). Washington, D.C.; on *Platanus* sp.; Aug. 1902 (Busck); 12 ex., 15.vii.1908. Massachusetts, Barnstable; 1 ex., 28.vii.1952 (Kimball). Alabama, Open Pond Cpgd., S. Andalusia, Covington Co.; 1 ♂, 18.iv.1976 (Heppner). Florida, Oneco, Manatee Co.; 1 ♂, 3 ex., 5—14.v.1953, 7.vi.1953 (Dillman). Siesta Key, Sarasota Co.; 2 ex., 30.iv. + 1.vi.1957 (Kimball). Pensacola; 1 ♀, 7.ix.1961 (Hills). Near Gainesville, Alachua Co., Archer Road Lab.; 1 ♂, 3 ex., 13.vi.1975, 4—5.v.1976 (Heppner); Gainesville; 1 ex., 11.xi.1974 (Greenbaum). Archbold Biol. St., Lake Placid, Highlands Co.; 2 ♂, 1 ♀, 6 ex., 1—8.v.1975 (Heppner). In CNC — Canada: Ontario, Normandale; on *Quercus rubra*; 1 ♂, 16.vi.1962 (Freeman and Lewis).

Mines examined: In ANS — USA: Ohio, Madisonville Swamp; 1 mine on *Platanus occidentalis*; 7.ix.1909, B.561¹⁾ (Braun).

Biology. — Egg. Laid on the lower surface of the leaf, sometimes near a vein.

Host. Braun reports that the mines of this species are abundant on the leaves of *Platanus* spp. and that adults may be found in large numbers on the trunks of the host. The single male bred from *Quercus rubra* is the only record of the species from that host.

Mine. Begins as a much contorted linear mine which is usually filled with frass. Several days before pupation, the mine abruptly enlarges into an almost circular blotch, which often eclipses the earlier portion of the mine. The frass is scattered evenly throughout the blotch (fig. 68).

Larva. Pale green in colour, emerges on the upper surface of the leaf.

Pupa. The cocoon is brown in colour.

Volitinism. Braun (1917) reports that there are three generations per year; the material examined here shows specimens to have emerged from early May to late July and reaching a peak in late June and early July. One specimen from Florida is dated November.

¹⁾ Some specimens of *Stigmella apicalbella* comb. n. were incorrectly labelled by Braun with this same breeding number.

***Ectoedemia clemensella* (Chambers)**
(figs. 15, 16)

Nepticula clemensella Chambers, 1873: 125.

Nepticula clemensella Chambers; Chambers in Hayden, 1878b: 157.

Nepticula clemensella Chambers; Dyar, 1903: 545.

Nepticula clemensella Chambers; Braun, 1917: 188.

Nepticula clemensella Chambers; Braun in Forbes, 1923: 93.

Nepticula clemensella Chambers; McDunnough, 1939: 107 (no. 9761).

Ectoedemia clemensella (Chambers); Wilkinson & Scoble, 1979: 86.

Description. — Fully described from Canada by Wilkinson and Scoble (1979).

Diagnosis. — Generally smaller and paler in colour than *platanella*; the males lack the chitinous plate of the hindwing which is found in *platanella*, *similella* and



Figs. 15, 16. *Ectoedemia clemensella* (Chambers), ♂ (15) and ♀ (16) genitalia.

virgulae. The setae of the valves are smaller and less furcate than those of any other species in the group and the saccus more markedly bilobed than in *similella*. The female genitalia are very similar to those of *platanella*.

Discussion. — Material has been examined from New York State; a locality not previously cited.

Distribution. — USA: — Ohio, Maryland, New York. Pennsylvania, Kentucky, Florida, Maine. Canada: — Ontario.

Material examined. — ♀ Lectotype: USA: Kentucky, (Chambers); slide no. CNC 3490; in MCZ. Paralectotype: In MCZ — 1 ex., "Peak Acad", "Type no. 14955".

Other specimens: In ANS — USA: Ohio, Cincinnati; on *Platanus* sp.; 2 ♂, 1.viii.1902, 1 ♂, 25.vii.1908, 3 ♀, 8,25,26.vii.1912, 1 ♂, 26.vi.1916, 1 ♀, 27.vi.1916, 1 ♂, 13.vii.1916 (Braun). In USNM — USA: Maryland, Plummers Island; 1 ex., v.1906 (Busch). Florida, Gainesville; on *Platanus occidentalis*; 3 ♂, 7 ♀, 8 ex., 11 + 14.v.1964 (Denmark); 1 ex., 5.viii.1963 (Denmark); 1 ex., 26.viii.1966 (O'Berry); Archbold Biol. Sta., Lake Placid, Highlands Co; 1 ex., 1.v.1975 (Heppner). Maine, Bar Harbour; 1 ♀, 27.v.1936 (Brower). In CNC — New York, Cornell University; 1 ♀, 1 ex., 6.iv.1885 (Murfeldt). Canada: Ontario, St. Williams; continue over on *Platanus occidentalis*; 3 ♂, 2 ♀, 16—26.ii.1960 (Freeman and Lewis). In SOO — Ontario, St. Williams; on *Platanus* sp.; 1 ♂, 20.iii.1962.

Mines examined: In ANS — USA: Ohio, Cincinnati; 2 mines on *Platanus* sp.; 26.vi.1909, B.452 (Braun); 7.ix.1909, B.562 (Braun). In CNC — Canada: Ontario, St. Williams; 19 mines on *Platanus occidentalis*; 3.ix.1959, 59—152, 59—153 (Lewis). In FIS — Ontario, St. Williams; several larvae, pupae and mines preserved in alcohol, 25.viii.1961, 561—7153—01.

Biology. — Mine. An upper surface ophistigmatonome in *Platanus occidentalis* comprising long linear tract terminating in small blotch. The frass line is central in the ophonome but absent in most of the blotch.

Voltinism. Reported as trivoltine (Braun, 1917).

***Ectoedemia similella* (Braun) comb.n.**

(figs. 2, 17, 18, 54, 55, 69)

Nepticula similella Braun, 1917: 188.

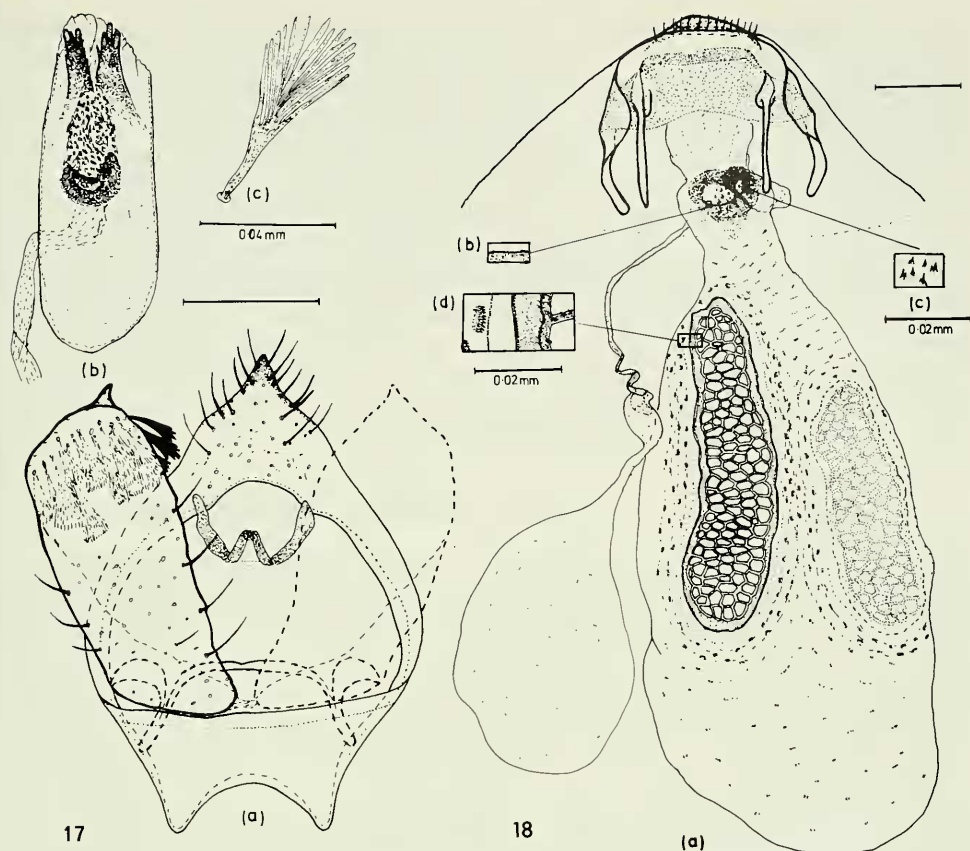
Nepticula similella Braun; Braun in Forbes, 1923: 93.

Nepticula similella Braun; McDunnough, 1939: 107 (no. 9762).

Description. — External features: ♂ ♀. As *platanella* except that: tuft on front of head orange ochreous, vertex paler. Ohio form: Forewings: ground colour of dorsal surface brown with scattered blue and purple reflections, distal half with each scale darker at the tip; single medial fascia, oblique, shining silver and occasionally reduced to marginal streaks. Fig. 54. Florida form: Forewings: ground colour very dark brown to black and uniformly dusted with grey reflections; markings barely visible as marginal patches of not more than five whitish scales; extreme apex of fringe creamy white, giving impression of an apical spot. Fig. 55.¹⁾

Wing expanse: ♂: 4.6—5.6 mm (22 specimens); ♀ 4.2—6.0 mm (16). Holotype: 5.2 mm.

¹⁾ See footnote page 58.



Figs. 17, 18. *Ectoedemia similella* (Braun), ♂ (17) and ♀ (18) genitalia.

Genitalia: ♂ (fig. 17). As *platanella* except that saccus is markedly bilobed, each lobe being as long as broad at base. Valves: rounded distally with small apical style; setae of dorsal surface broad and fan-like as in fig. 17 (c). Aedeagus: markedly shorter than the capsule; anellus comprising a pair of blunted, digitate processes.

Female (fig. 18). As *platanella* except that sclerotised double ring with inner margin weakly serrate, as in fig. 18 (b) and lobe of ductus with small triple spicules as in fig. 18 (c). Bursa copulatrix: signa small in relation to the bursa and unequal in size.

Host plant: *Quercus palustris*, *Quercus rubra*.

Mine: An ophistigmatonome.

Diagnosis. — More often smaller and more iridescent than *platanella* and *clemensella* and differs in the irrorate nature of the forewing ground colour. This species has the lance-shaped chitinous plate on the male hindwing which is absent in *clemensella*. The saccus is more markedly bilobed than in *platanella* and *virgulae* but less than in *clemensella*. The broad, fan-like scales of the valves differ from those of *platanella*, *clemensella* and *virgulae*. The female genitalia resemble those of

the other members of the group in most respects: the unequal size of the signa and the very small spicules of the lobe are the only consistent differences. The mine is easily separated from the lower surface ophionome produced by *Stigmella altella* (Braun) **comb.n.**, which is also found on *Quercus palustris*.

Discussion. — The pattern of wing markings, although resembling that of other members of the species group, is most variable in *similella*. There are two forms: those with a complete fascia which is occasionally reduced to marginal streaks as in *platanellaa* and *clemensella*, which is found in Ohio, New Jersey and Virginia and referred to here as the Ohio form; and those with greatly reduced marginal patches and a diffuse apical patch of off-white ciliae, which is known only from Florida.¹⁾ The Ohio form is that originally described by Braun (*loc.cit*) from ten bred specimens on *Quercus palustris* in Ohio. There is a single female (Specimen 6) from Arkansas, with externals intermediate between the two forms: the forewings are dark chocolate brown with an apical patch of cream, as in the Florida form, and there is a single medial fascia, as in the Ohio form.

Distribution. — USA: — Ohio, New Jersey, Illinois, Virginia, Florida, Arkansas, Kentucky, Maine?

Material examined. — ♂ Holotype: USA: "B.649; Cincinnati, Ohio. Annette F. Braun, i. 21.vi.1914; Type Collection of Annette F. Braun; *Nepticula similella* Braun Holotype"; on *Quercus palustris*; slide no. 109-PJN; in ANS. Paratypes: In ANS — USA: Ohio, Cincinnati; on *Quercus palustris*; 1 ♂, 18.vi.1914, 1 ♂, 22.vi.1914, 1 ♂, 2 ♀, 24.vi.1914, 1 ♀, 27.vi.1914, 1 ♀, 30.vi.1914, 1 ♀, 7.vii.1914, B.649 (Braun). In DFF — Ohio, Cincinnati; on *Quercus palustris*; 1 ♀, 22.vi.1914, B.649 (Braun); slide nos. 107-PJN, 108-PJN, CNC 3479.

Other specimens: In ANS — USA: Ohio, Cincinnati; on *Quercus palustris*; 1 ♂, 2.vi.1922, 2 ♀, 17.vi.1922, 1 ♂, 3 ♀, 21.vi.1922, 1 ♀, 28.vi.1922, B.649 (Braun); on *Quercus rubra*; 1 ♀, 10.vi.1918, B.965 (Braun). In USNM — New Jersey, Anglesea; 1 ♀, "V.30" (Kearfott). Virginia, Mountain Lake; 1 ♂, 24.vii.1940 (Milne and Milne). Illinois, Putnam Co.; 2 ♂, 14.vii.1969, 23.vii.1970 (Glenn). Maine, Millinocket; 1 ex., 11.vii.? Florida, Archbold Bio. Sta., Lake Placid; 1 ♂, 1—7.v.1964, 1 ♂, 2 ♀, 8—15.v.1964, 3 ♂, 16—22.v.1964 (Hodges). Oneco, Manatee Co.; 8 ♂, 5—14.v.1953, 3.ix.1953, 2.xi.1953 and 17.xi.1954 (Dillman). Gulf Coast Exp. Sta., Bradenton; 1 ♂, 24.iii.1955 (Keisheimer).

Specimen 6: In USNM — USA: Arkansas, Devil's Den St. Pk., Washington County; 1 ♀, 24.vi.1966 (Hodges); *al. ex.* 5.6 mm; slide no USNM 17256.

Mines examined: In ANS — USA: Ohio, Cincinnati; 2 mines on *Quercus palustris*; 30.viii.1911, B.649 (Braun); 3 mines on *Quercus rubra*; 21.x.1917, 8.965 (Braun).

Biology. — Egg. Laid on the upper surface.

Host. Braun (1917 and breeding records) reports that similar mines have been

¹⁾ Footnote Post Scriptum: Since the description of this species was written, more material has become available from Florida. Some of these specimens have complete fasciae, whilst retaining other characters of the dark form. It still remains that Florida is the only state recording the form with incomplete fasciae, but it now seems unlikely that the variation is geographically based as was first thought probable (CW).

found on chestnut in Kentucky although the material in question cannot be located.

Mine. The early part of the mine is very narrow and much contorted in close S-shaped curves, with the frass scattered throughout its breadth. The larva then forms a lower surface blotch in which the frass is deposited as a congealed mass at the beginning (fig. 69).

Larva. Pale green in colour, emerging on the lower surface in most cases.

Pupa. Cocoon ochreous in colour.

Voltinism. Adults have been taken in May, throughout June and early July, while late instar larvae are found from July to October. It is possible that there are up to three broods per year.

***Ectoedemia virgulae* (Braun) comb.n.**
(figs. 19, 20, 56, 57, 70)

Nepticula virgulae Braun, 1927: 198.

Nepticula virgulae Braun; McDunnough, 1939: 107 (no: 9751).

Description. — External features: ♂ ♀. As *platanella* except that tuft on front of head orange-ochre, vertex paler. Thorax and abdomen dark brown with bronze reflections. Forewings: ground colour of dorsal surface brown to very dark chocolate brown with bronze and purple reflections, distally each scale darker at the tip; single medial fascia, variable in breadth, oblique, shining silver and markedly concave inwardly. Figs. 56 (♀ Ohio) and 57 (♂ Florida).

Wing expanse: ♂: 3.8—5.0 mm (12 specimens); ♀: 4.0—5.8 mm (19). Holotype: 4.0 mm.

Genitalia: ♂ (fig. 19). As *platanella* except that valves markedly concave along inner margin distally; setae of dorsal surface terminally digitate, with long basal shaft as in fig. 19 (c). Aedeagus: markedly shorter than the capsule; anellus comprising a pair of bifurcate plates as in fig. 19 (b).

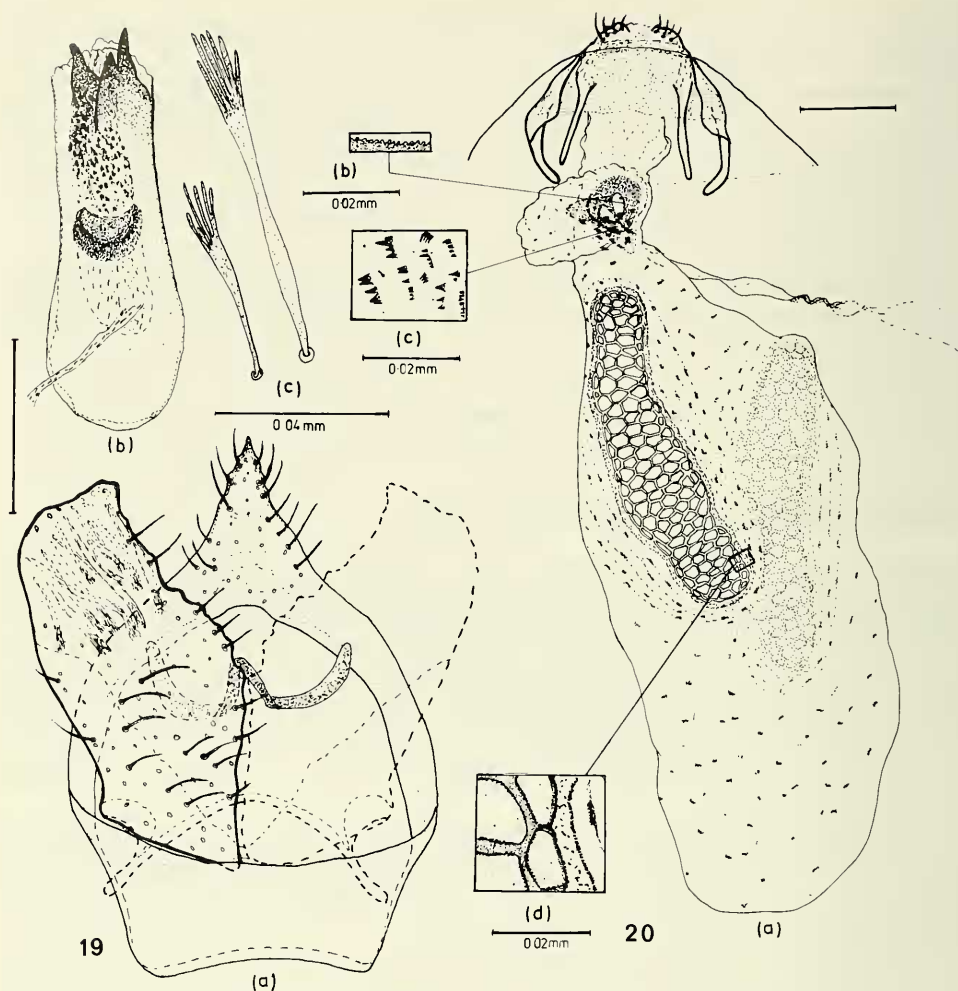
Female (fig. 20). As *platanella* except that sclerotised double ring with inner margin markedly serrate, as in fig. 20 (b), and lobe of ductus with large triple spines as in fig. 20 (c). Bursa copulatrix: signa small in relation to the bursa.

Variation. In externals, the ground colour of the forewings varies in intensity from the pale form in Ohio to dark chocolate brown in Florida and Texas. The breadth of the fascia varies and is broadest in those specimens examined from Florida. Similarly, there is a greater degree of variation in the male genitalia than is found in other members of the species group. The pseuduncus ranges in length and shape from the short, blunted form in Florida to a longer more tapering form in Ohio and Texas (fig. 19). The setae of the valves are more heavily sclerotised and longer in Florida males than in those from Ohio and Texas illustrated in fig. 19 (c).

Host plant: *Corylus americana*.

Mine: An upper surface ophionome.

Diagnosis. — More often smaller than *platanella* or *clemensella* and differs in the irrorations and reflections of the forewings; as far as observed the fascia is always complete in *virgulae*. The saccus is more weakly bilobed and the valves more



Figs. 19, 20. *Ectoedemia virgulae* (Braun), ♂ (19) and ♀ (20) genitalia.

concave along the inner margin than in *similella* or *clemensella*. The setae of the valves differ from those of *platanella*, *clemensella* and *similella* in the longer shaft and the longer terminal ciliae. The female genitalia resemble those of the other members of the group; the large, triple spines of the accessory lobe and the smaller signa separate them from *platanella*. The mine is broader than that of *Stigmella corylifoliella* (Clemens), but narrower than *Stigmella ostryaefoliella* (Clemens), both of which are also found on *Corylus* sp.

Discussion. — Originally described from four bred specimens on Hazel (*Corylus americana*). The variation in externals of the material examined here shows a similar geographical distribution to that in *similella*: a darker form being recorded in the southern states (Florida and Texas). In *virgulae*, however, this also corresponds with a difference in the male genitalia of the Florida specimens. In the two males from Texas the transtilla are much stouter than in the type; this may be due

to distortion but is possibly a geographical or seasonal difference (these adults were on the wing in September).

Distribution. — USA:— Ohio, Texas, Florida.

Material examined. — ♂ Holotype: USA: "B.1107, Clinton County, Ohio, 24.iv.1925; Type; *Nepticula virgulae* Braun type"; on *Corylus americana*; slide no. 100-PJN; in ANS. ♀ Allotype: same data as Holotype; i.15.v.1925; slide no. 102-PJN; in ANS. Paratypes: In ANS—USA: same data as Holotype; Ohio, Clermont County; 1 ♂, 1 ♀, vii.1924; slide nos. 101-PJN, 103-PJN.

Other specimens: In USNM—USA: Texas, Bexar County; 2 ♂, 3 ♀, 11.ix.1959 (McGregor). Florida, Lake Placid, Archbold Bio. Sta.; 6 ♂, 5 ♀, 8—15.v.1964, 3 ♂, 7 ♀, 16—22.v.1964 (Hodges). Florida, Fisheating Creek, Palmdale; 2 ♀, 7—10.v.1964 (Hodges).

Biology. — Mine. A gradually broadening linear mine with the frass scattered in a broad tract (fig. 70).

Larva. Green in colour.

Pupa. Cocoon reddish brown in colour.

Voltinism. Possibly bivoltine in Ohio, with adults emerging in April, May and July; Braun's breeding records show that late instar larvae are present in August and September. Adults have also been taken in May from Florida and in September from Texas.

THE RUBIFOLIELLA GROUP

This group has three species, *rubifoliella*, *ulmella* and *quadrinotata* with the pseuduncus prolonged backwards but bluntly rounded; the aedeagi have moderately large, similar, anellar projections in males, and females are without thickened or sclerotised collicula. The species *nyssaefoliella* is assigned here on the grounds that the female is typical, having no colliculum. It has unusually broad and enlarged anterior apophyses. The male however is more typical of the *populella* group with the pointed pseuduncus. However the aedeagus (like specimen 8) is devoid of any large spines or anellar projections. Another species which does not conveniently fit into a species-group is *lindquisti* which in the male looks like *quadrinotata* but with smaller anellar spines and more pointed pseuduncus. It also has similarities with the preceding groups as indicated in the species diagnosis. The female has the sclerotised ring-shaped colliculum reminiscent of *populella*.

Ectoedemia lindquisti (Freeman) (figs. 21, 22, 43)

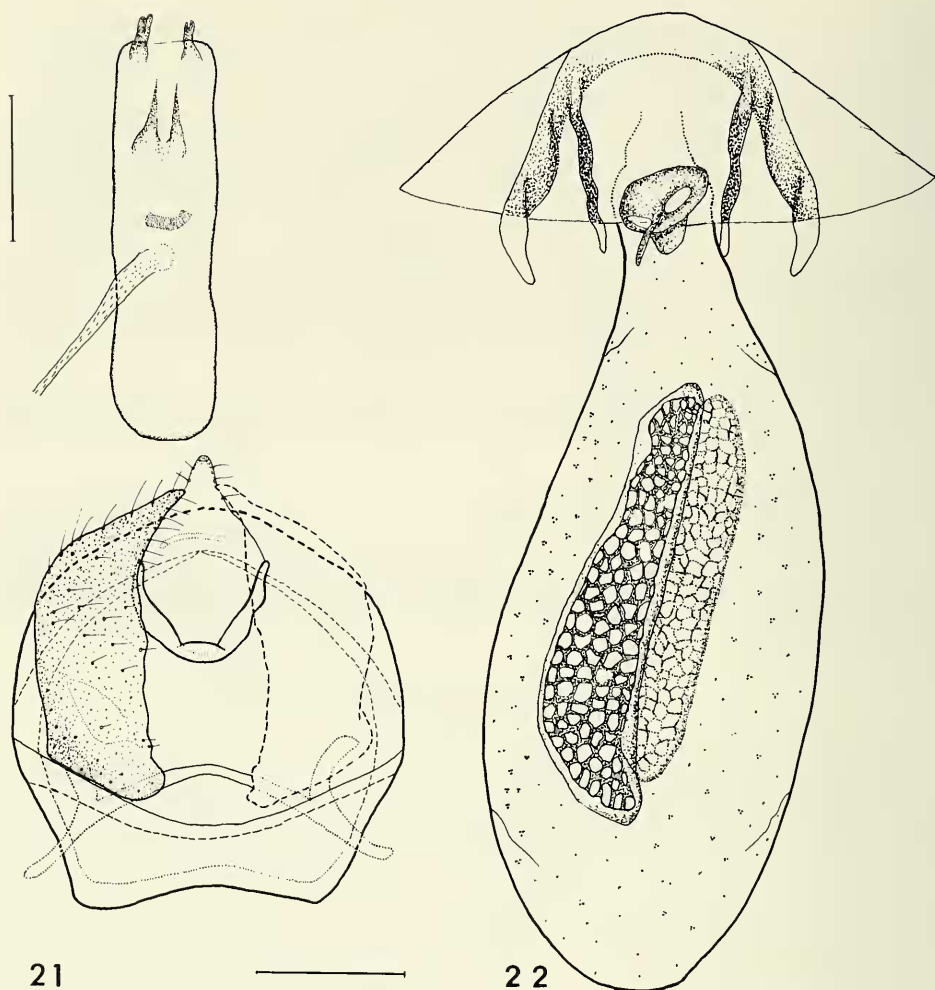
Nepticula lindquisti Freeman, 1962: 522.

Nepticula lindquisti Freeman; Lindquist, 1962: 524.

Ectoedemia lindquisti (Freeman); Wilkinson & Scoble 1979: 83.

Description. — Fully described from Canada by Wilkinson & Scoble (1979).

Diagnosis. — The darker tufts on the head and the generally darker ground colour separate *lindquisti* from the members of the *platanella* group. Differs from *marmaropa* in the absence of the basal patch of the forewings. The genitalia re-



Figs. 21, 22. *Ectoedemia lindquisti* (Freeman), ♂ (21) and ♀ (22) genitalia.

semble those of the *platanella* group but differ in the absence of the setae of the valves, in males, and the lobe of the colliculum, in females. The digitate processes of the aedeagus are less complex than those in *similella* and *marmaropa* (compare fig. 21 with figs. 17 and 11).

Discussion. — Additional specimens to those cited by Wilkinson & Scoble (1979), from Maine indicate that the species has a wider distribution than has been previously cited. One male has darker head tufts than is usual for the species, but is otherwise indistinguishable. See also discussion for *canadensis*, p.

Distribution. — USA:— Maine. Canada:— Ontario.

Material examined. — ♂ Holotype: Canada. Ontario, Lake Huron, Wiarton; on *Betula papyrifera*; 13.vi.1959, 559.0049.01; Type no.: 7752; in CNC. Paratypes: In CNC—Canada: data as Holotype; 26 ♂, 12 ♀, 8.vi.—1.viii.1959.

Other specimens: In ANS—USA: Maine, Bethel; 2 ♂, 1 ♀, 29.vi.1946 (Braun).

Canada: data as Holotype; 1 ♀, 8.vi.1959. In SOO—Ontario, Trout Creek; on *Betula alleghaniensis*; 1 ♀, 24.iii.1958.

Biology. — A thorough study has been made by Lindquist (1962) for whom the species was named by Freeman.

Egg. Laid on underside of *Betula* leaves (*B. papyrifera*, *B. alleghaniensis* = *lutea*), sometimes in large numbers on one leaf.

Mine. Is an upper surface stigmatonome with a more or less rectangular blotch between two leaf veins. Frass is deposited in circular patches.

Larva. Whitish in colour with translucent integument and pale yellow head.

Cocoon. Yellow-brown darkening with time and deposited in soil and litter. Larva overwinters in cocoon.

Voltinism. Univoltine.

***Ectoedemia rubifoliella* (Clemens)**

(figs. 23, 24, 49)

Nepticula rubifoliella Clemens, 1860: 214.

Nepticula rubifoliella Clemens; Clemens, 1865: 146.

Nepticula rubifoliella Clemens; Clemens in Stainton, 1872: 32, 42, 45, 152.

Nepticula rubifoliella Clemens; Chambers in Hayden, 1878b: 158.

Nepticula rubifoliella Clemens; Dyar, 1903: 547.

Nepticula rubifoliella Clemens; Busck, 1903: 208.

Nepticula rubifoliella Clemens; Braun, 1917: 183.

Nepticula rubifoliella Clemens; Braun in Forbes, 1923: 91.

Nepticula rubifoliella Clemens; McDunnough, 1939: 107 (no: 9750).

Ectoedemia rubifoliella (Clemens); Wilkinson & Scoble, 1979: 90.

Description. — Fully described from Canada by Wilkinson & Scoble (1979).

Diagnosis. — Resembles *virgulae* in externals, although *rubifoliella* is generally darker and the fascia broader. The males lack the chitinous plate of the hindwings found in *virgulae*. The nature of the pseuduncus and the relatively short aedeagus separates the male genitalia from those of *ulmella* and *quadrinotata*, whilst the females differ only in the relative sizes of the signa.

Distribution. — USA:— Ohio, Kentucky, Pennsylvania (Clemens). Canada:— Ontario, Quebec.

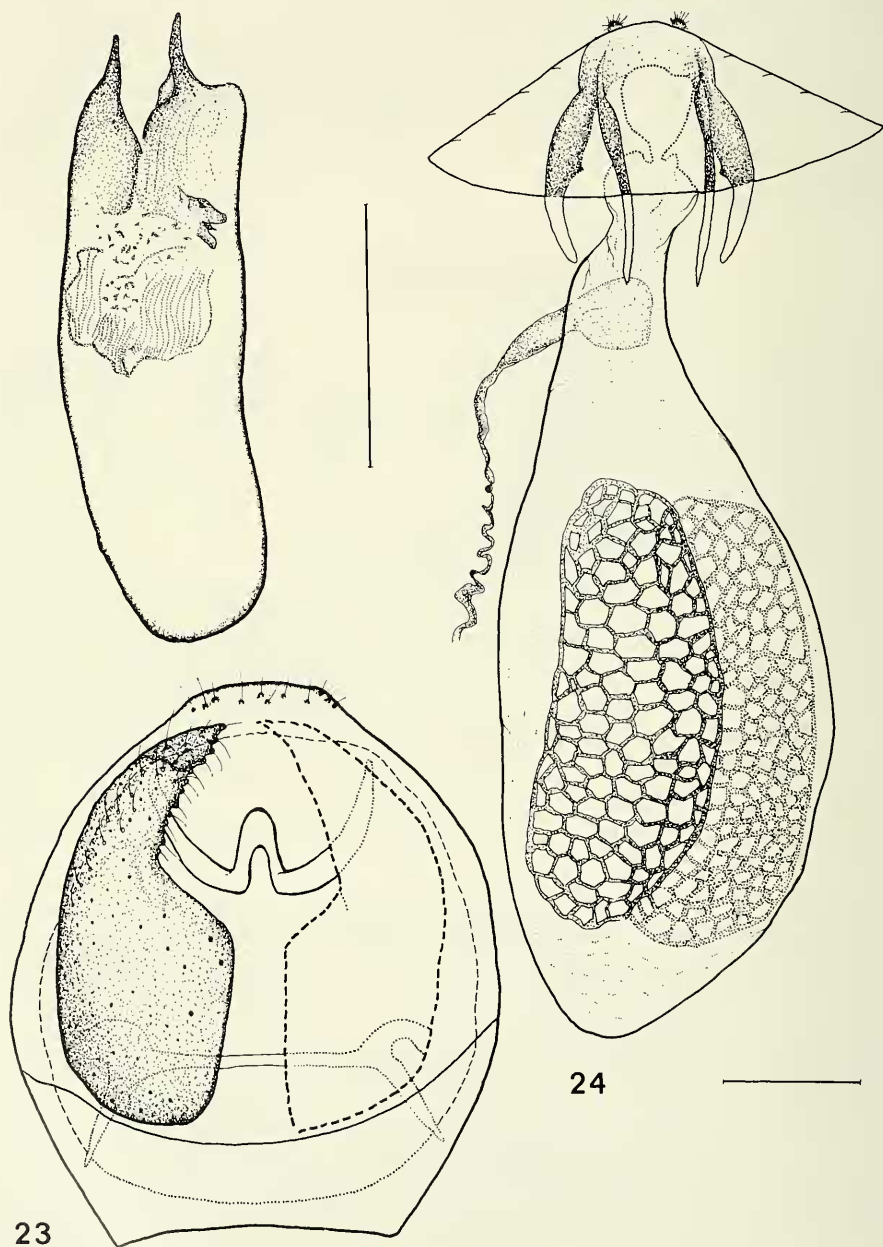
Material examined. — ♂ Neotype: USA: Ohio, Cincinnati; on *Rubus* sp.; 23.v.1916 (Braun); slide no: USNM 17339; in ANS.

Other specimens: In USNM — USA: data as neotype; 2 ♀, 18.viii.1912, 1.vi.1916 (Braun). Kentucky, Red Bird River; 1 ♂, 19.viii.1933 (Braun). In CNC — Canada: Ontario, Simcoe; on *Rubus* sp.; 1 ♂, 14.ii.1966 (Freeman). Quebec, Hull; on *Rubus* sp.; 2 ♀, 21.iii.1959 (Freeman and Lewis); 1 ex., 31.iii.1957 (Freeman). Mines examined: In ANS — USA: Ohio, West Fork Woods; 1 mine on *Rubus* sp.; 6.ix.1909, B.558 (Braun); 1 mine on *Rubus* sp.; 4.vii.1909, B.558 (Braun). In CNC — Canada: Ontario, Simcoe; 5 mines on *Rubus* sp.; 1965, 65—74 (Freeman). Quebec, Hull; 3 mines on *Rubus* sp.; 1965, 56—257 (Freeman and Lewis).

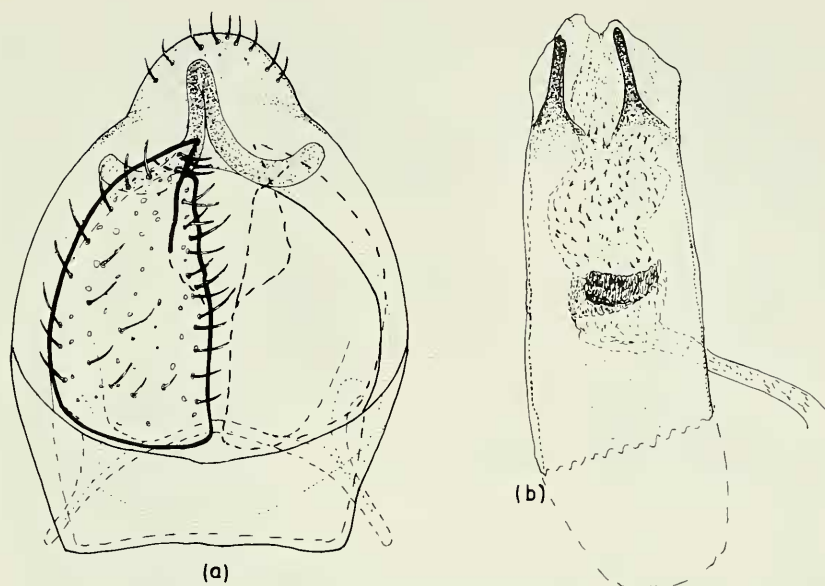
There is a single male with externals and genitalia similar to *rubifoliella* except that the ground colour is paler and the pseuduncus, valves and gnathos differ as in fig. 25. According to the label data this specimen was reared from *Quercus plata-*

noides (the same series of mines from which Braun reared examples of *Stigmella flavipedella* (Braun)). If this is correct then the mine differs from that of *rubifoliella* in that it is a much contorted linear tract.

Specimen 7: In ANS — USA: Ohio, Cincinnati; on *Quercus platanoides*; 1 ♂, 30.v.1922, B.653 (Braun); *al.ex.* 4.4 mm.; slide no: 130-PJN.



Figs. 23, 24. *Ectoedemia rubifoliella* (Clemens), ♂ (23) and ♀ (24) genitalia.



25

Fig. 25. *Ectoedemia*, specimen 7, ♂ genitalia.

Biology. — Mine. A linear tract is made in *Rubus* (Blackberry) leaves and the frass-line is broken and central. It then widens into a rather elongate blotch forming an upper surface ophistigmatonome with the frass irregularly dispersed.

Pupa. Cocoon is dark brown.

Voltinism. Braun (1917) reports 2 generations.

***Ectoedemia ulmella* (Braun)**

(figs. 26, 27)

Nepticula ulmella Braun, 1912: 87.

Nepticula ulmella Braun; Braun, 1917: 186.

Nepticula ulmella Braun; Braun in Forbes, 1923: 92.

Nepticula ulmella Braun; McDunnough, 1939: 107 (no: 9758).

Ectoedemia ulmella (Braun); Wilkinson & Scoble, 1979: 91.

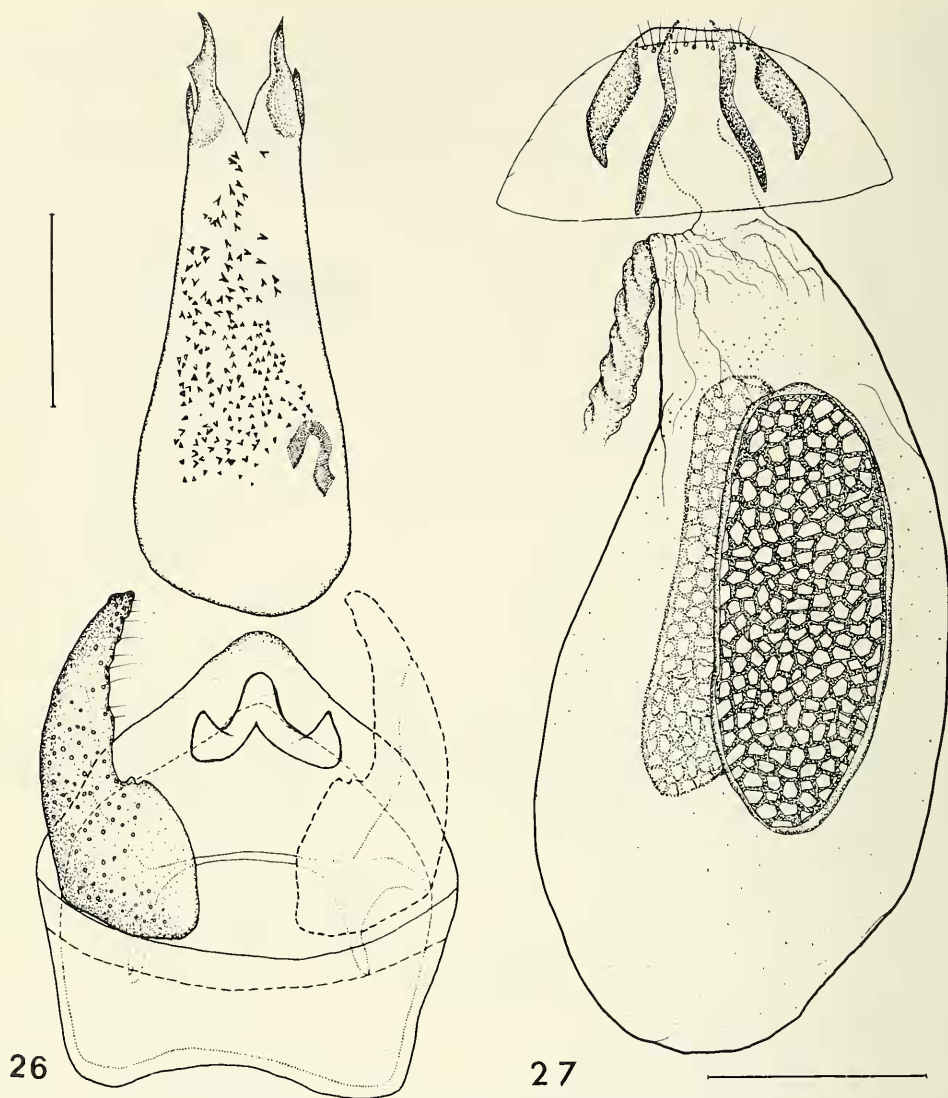
Description. — Fully described from Canada by Wilkinson & Scoble (1979).

Diagnosis. — Larger and less iridescent than *rubifoliella*. The tapering valves and the broad gnathos separate the males from those of *rubifoliella*, while the only consistent difference in the females is the smaller and more ovate signa retinacula of *ulmella*.

Discussion. — We have examined an additional male from New York which indicates that the species has a wider distribution than has been previously cited.

Distribution. — USA:— Ohio, Pennsylvania, New York, Kentucky. Canada:— Ontario, Quebec.

Material examined. — ♂. Lectotype: USA: Ohio, Cincinnati; on *Ulmus* sp.;



Figs. 26, 27. *Ectoedemia ulmella* (Braun), ♂ (26) and ♀ (27) genitalia.

18.viii.1912, B. 578 (Braun); slide no: USNM 16251; in ANS. Paralectotype: In ANS — USA: Ohio, Clermont Co., on *Ulmus* sp.; 1 ♀, 10.viii.1912 (Braun).

Other specimens: In ANS - USA: Ohio, Cincinnati; Overbook; on *Ulmus americana*; 1 ex., 27.vii.1955 (Lewis); on *Ulmus* sp.; 1 ♀, no date (Braun), 1 ♂, 24.vi.1905, 1 ♀, 8.vi.1912, 1 ♂, 1 ♀, 3.vii.1907, 1 ex., 6.ix.1954 (Braun). In USNM - Pennsylvania, Pittsburgh; 1 ♂, 23.vii.1906 (Engel). New York, Cornell University, Ithaca; on *Ulmus* sp.; 1 ♂, no date (Murfeldt). In CNC — Canada: Quebec, Kingsmere; on *Ulmus fulva*¹); 2 ♂, 3 ♀, 2 ex., 12—30.vii.1956 (Lewis). Ontario, La Pisse; on *Ulmus americana*; 1 ♀, 25.ii.1971, 1 ♂, 22.ii.1971, 1 ♂, 26.iii.1971 (Lewis).

Mines examined: In ANS — USA: Ohio, Anderson's Ferry; 1 mine on *Ulmus fulva*¹); 20.ix.1909, B.578 (Braun); 1 mine on *Ulmus racemosa*; 21.vii.1913, B.578 (Braun). In CNC — Canada: Ontario, Kingsmere; 2 mines on *Ulmus rubra*; 11.ix.1955, 55—281 (Lewis). Ontario, La Passe; 1 mine on *Ulmus americana*; 16.ix.1970, 70—111A (Rockburne and Lewis). Ontario, Ottawa; 5 mines on *Ulmus americana*; 7.viii.1955, 55—137A (Lewis). Quebec, Kingsmere; 3 mines on *Ulmus rubra*; 10.ix.1955, 55—279 (Lewis); 2 mines on *Ulmus fulva*¹); 10.ix.1955, 55—279 (Lewis).

Biology. — Mine. Is a much contorted frass filled tract in leaves of several species of *Ulmus* including *U. rubra* (Slippery or Red Elm), *U. americana* (White Elm) and *U. thomasi*¹) (Rock or Cork Elm). The tract expands into a blotch so producing an upper surface ophistigmatonome. The frass is deposited in both patches and lines.

Cocoon. Reddish brown and usually spun within the mine-blotch.

Voltinism. Bivoltine with mature larvae present in July and September (Braun, 1917).

***Ectoedemia nyssaefoliella* (Chambers) comb.n.**

(figs. 28, 29, 58, 59, 71)

Nepticula nyssaefoliella Chambers, 1880: 66.

Nepticula nyssaefoliella Chambers; Dyar, 1903: 546.

Nepticula nyssaefoliella Chambers; Braun, 1909: 429.

Nepticula nyssaefoliella Chambers; Braun, 1917: 183.

Nepticula nyssaefoliella Chambers; Braun in Forbes, 1923: 91.

Nepticula nyssaefoliella Chambers; McDunnough, 1939: 107 (no: 9752).

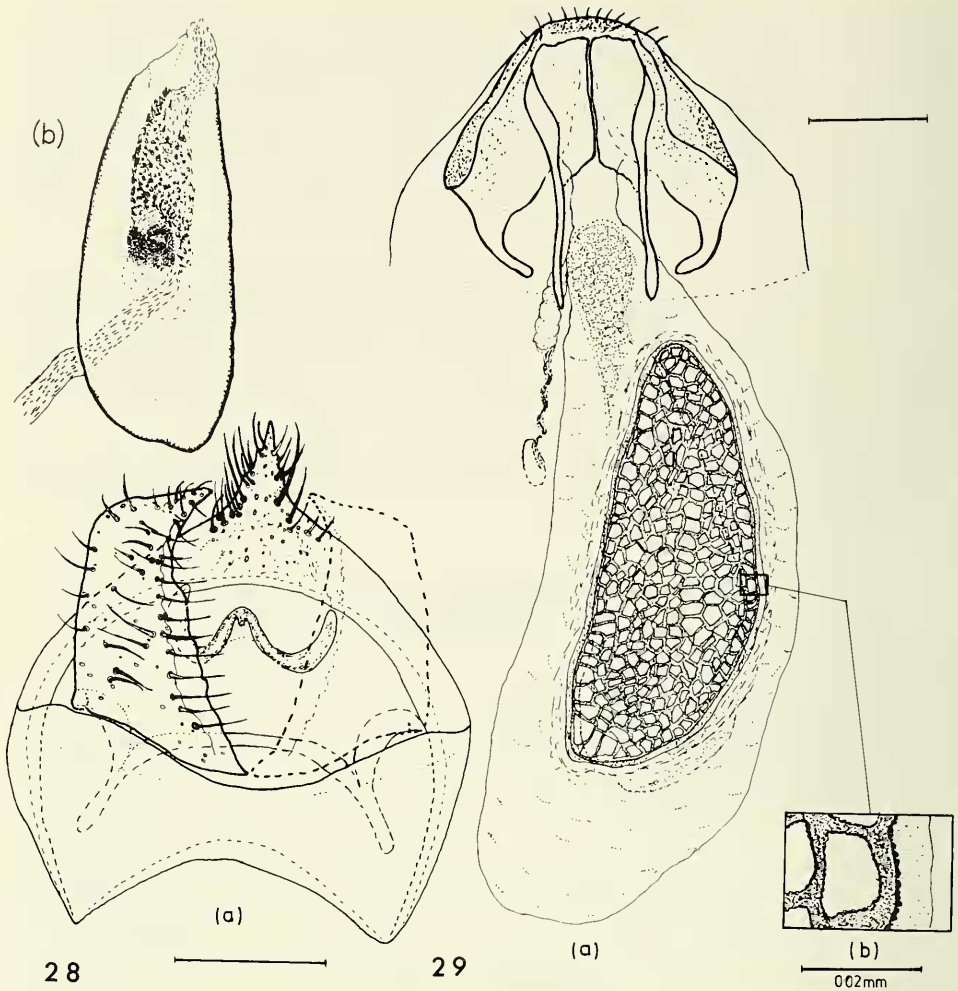
Description. — External features: ♂. Head: Palps greyish; antennae dark brown; tuft on front of head ochreous, vertex orange-ochreous; eye-caps shining white; collar pale ochre. Thorax and abdomen dark brown, thorax with purple reflections, abdomen with silver reflections above, shining metallic grey beneath. Forewings: ground colour of dorsal surface dark brown with bronze reflections which become stronger towards the apex, distal scales darker at the tips; fringe greyish brown, shining silver, with an apical band of dark brown wing-scales; single medial fascia, shining silver, biconcave. Hindwings: ground colour and fringe brownish grey; an oval patch of creamy white scales extending from base to middle of dorsal surface, sometimes absent. Legs dark brown, shining silver behind. Fig. 58.

Female. As ♂ except for hindwings without specialised scales. A pair of convex external pockets on ventral side of the fourth abdominal segment, medial in position (fig. 59).

Wing expanse: ♂: 4.2—6.4 mm (14 specimens); ♀: 4.6—6.4 mm (14). Neotype: 5.0 mm.

Genitalia: ♂ (fig. 28). Pseuduncus with a single tapering lobe. Gnathos: W-shaped as in fig. 28 (a); transverse ventral plate with broad central boss. Vinculum:

¹) N.B. *Ulmus rubra* Muhl. = *U. fulva* Michx. *Ulmus racemosa* Thomas = *U. thomasi* Sarg.



Figs. 28, 29. *Ectoedemia nyssaefoliella* (Chambers), ♂ (28) and ♀ (29) genitalia.

lateral arms broad, ventral plate narrow. Saccus more than two-times the width of the ventral plate, bilobed. Valves not reaching beyond the pseuduncus, quadrate with a triangular style arising distally. Transtillae: lateral arms narrow; ventral arms long and narrow, reaching well beyond the ventral plate; transverse arms fused. Aedeagus: regular in width, approximately equal to length of the capsule; vesica with cornuti as many small denticles and with a cup-shaped plate of minute papillae.

Female (fig. 29). Ductus bursae short and narrow with spiral duct arising medially. Bursa copulatrix: large and covered with scallop-shaped chains of pectinations on striations of the bursa; signum double, comprising a pair of unequal cellular patches, one ovate and one constricted proximally, as in figs. 29 (a) and (b). Anterior apophyses very broad basally, tapering markedly. Posterior apophyses straight and narrow, reaching beyond the anteriores.

Host plant: *Nyssa sylvatica* (Sour Gum).

Mine: An upper surface ophistigmatonome.

Diagnosis. — Generally darker and the fascia narrower than in *platanella* or members of the *platanella* group. The male genitalia are easily differentiated from those of any other member of the genus, listed on page 37, by the absence of the anellar processes. The females resemble those of *rubifoliella*, *ulmella* and *quadri-notata* in the absence of a strongly sclerotised colliculum but may be separated by the unequal signa, one of which is constricted proximally, in *nyssaefoliella*.

Discussion. — This species was originally described by Chambers (1880) from the mine; adults reared from *Nyssa* sp. were described by Braun (1909) and given the same name. Although the mine(s) constitute the original type material, they were never preserved or designated. Braun (1909) does not mention the specialised scale patch present in some specimens in her first description of the imago, but does so in a later publication (1917). All the male specimens dated 1909 or earlier and presumably described by Braun (1909), possess the specialised scale patch, those collected at later dates and presumably described by Braun (1917) do not show evidence of specialised scale patches. We designate as Neotype one of the males examined by Braun in 1909, which possesses specialised scale patches.

It is not unlikely that these two forms of male represent separate species; but in the absence of any further evidence we treat them as one. Several examples of the loss of such specialized scales later in life are known within the Lepidoptera, although this is the first possible example in the Nepticulidae.

There are two females reared from *Amelanchier* sp. by C. Heinrich with indistinguishable genitalia from those of *nyssaefoliella*. The externals of two females differ from the type of *nyssaefoliella* (which is similar to the others) in the more irrorate nature of the forewings and the broader fascia. The differences may result from the different host plant but may indicate a separate species. "*Nepticula amelanchierella*" Clemens, 1861, was described and is still only known from the mine.

Distribution. — USA:— Ohio, Virginia, New Jersey, Kentucky.

Material examined. — Designated as neotype: 1 ♂ from the series examined by Braun 1909: USA: "B. 454, Cincinnati, Ohio. Annette F. Braun, 31.vii.1909: *Nepticula nyssaefoliella* Cham." — on *Nyssa sylvatica*; slide no: 138-PJN; in ANS.

Other specimens: In ANS — USA: Ohio, Cincinnati; 3 ♂, 4 ♀, 20.vi.1911 (Braun); on *Nyssa sylvatica*; 1 ♀, 25.vii.1909, 3 ♂, 3, 16, 17.viii.1909, 2 ♂, 1 ♀, 27.vi.1911, 1 ♀, 22.vi.1914, B.454 (Braun). In USNM — Ohio, Cincinnati; 1 ♀, 26.vi.1907 (Braun); on *Nyssa sylvatica*; 1 ♀, 27.vi.1911, B.454 (Braun); 1 ♂, 15.vi.1911; 4 ♂, 2 ♀, 20.vi.1911, 1 ♀, 26.vi.1916 (Braun). New Jersey, Anglesea; 1 ♀, v, 30 (Kearfott). In FIS — Virginia, Mountain Kale; "WH 3"; 2 ♂, 21.vii.1940 (Milne and Milne).

Tentative identifications: In USNM — USA: Virginia, Falls Church; "11153 Hopk. US"; on *Amelanchier* sp.; 1 ♀, 3.vii.1913 (Reared C. Heinrich). In DFF — 1 ♀, same data.

Mines examined: In ANS — USA: Ohio, Ferris Woods; 1 mine on *Nyssa sylvatica*; 28.vi.1909, B.454 (Braun).

Biology. — Egg. Laid on the lower surface and, in the single case observed, next to the midrib of the *Nyssa* leaf.

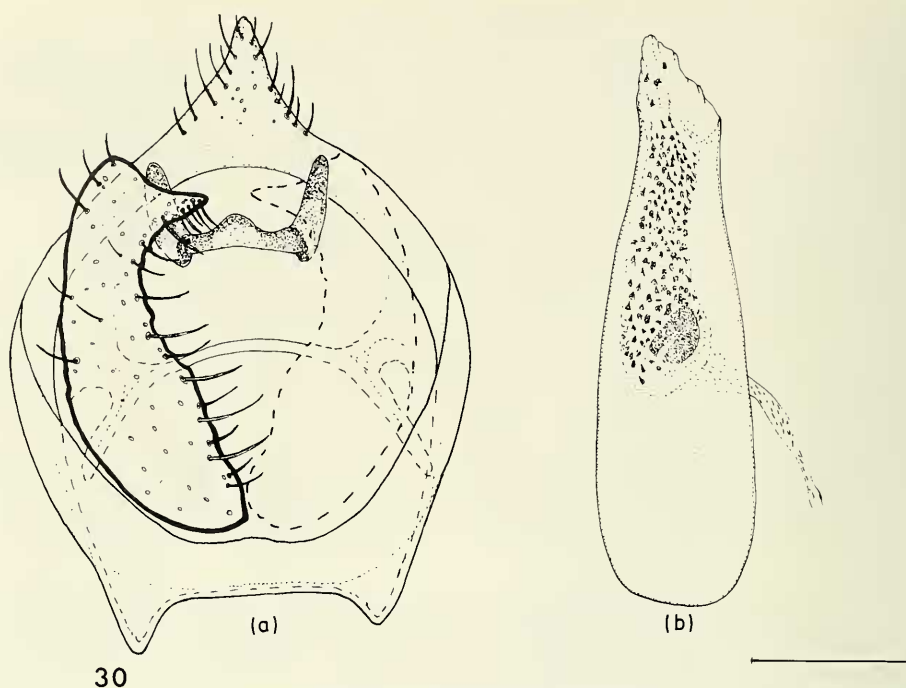


Fig. 30. *Ectoedemia*, specimen 8, ♂ genitalia.

Mine. Begins as a very narrow linear tract which abruptly broadens into an elongate blotch on the upper surface. The frass is deposited as a continuous black line in the centre of the linear portion and in a much contorted tract throughout the blotch (fig. 71).

Larva. Emerges on the upper surface of the leaf.

Pupa. Pale green in colour.

Voltinism. Two or possibly three generations per year.

There is a single male with externals as *nyssaefoliella* except that the ground colour of the forewings is darker and the *al. ex.* greater by almost 1 mm. The genitalia of this specimen resemble those of *nyssaefoliella* in overall form but differ in the gnathos, which is more typical of *Stigmella* rather than *Ectoedemia*, and the relatively larger aedeagus, see figs. 30, 60.

Specimen 8: In ANS — USA: Ohio, Cincinnati; 1 ♂, 20.vi.1911 (Braun); *al. ex.* 7.0 mm.; slide no: 135-PJN.

***Ectoedemia quadrinotata* (Braun)**
(figs. 31, 32, 48)

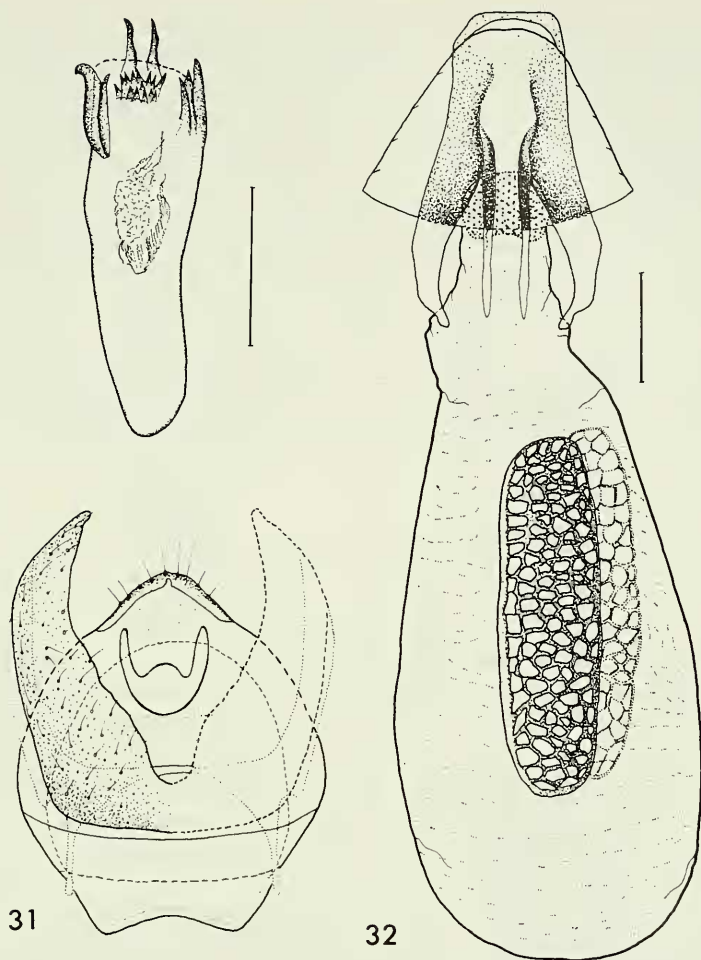
Nepticula quadrinotata Braun, 1917: 168.

Nepticula quadrinotata Braun; Braun in Forbes, 1923: 86.

Nepticula quadrinotata Braun; McDunnough, 1939: 107 (no: 9722).

Ectoedemia quadrinotata (Braun); Wilkinson & Scoble, 1979: 95.

Description. — Fully described from Canada by Wilkinson and Scoble (1979).



Figs. 31, 32. *Ectoedemia quadrinotata* (Braun), ♂ (31) and ♀ (32) genitalia.

Diagnosis. — The externals resemble those of *trinotata* except that there are two antemedial spots in *quadrinotata*. The tuberculate pseuduncus and the elaborate anellar processess differentiate the male from other members of *Ectoedemia* studied here. The female genitalia resemble those of *rubifoliella*, *ulmella* and *nys-saefoliella* but differ in the presence of a weakly sclerotised colliculum in *quadrinotata*.

Discussion. — A specimen found in USNM collection taken in Arkansas, indicates that the species has a wider distribution than has been recorded previously.

Distribution. — USA:— Ohio, Arkansas, Kentucky. Canada:— Ontario.

Material examined. — ♀. Holotype: USA: Ohio, Cincinnati; on *Carpinus* sp.; 28.v.1914, B.538 (Braun); slide no: USNM 17326; in ANS. Paratypes: In ANS — USA: data as Holotype; 2 ♂, 1 ♀, 27—30.v.1914 (Braun); Sugar Grove; on *Corylus* sp.; 1 ♂, 1 ♀, 1.vi.1915 (Braun).

Other specimens: In USNM — USA: Ohio, Cincinnati; on *Carpinus* sp.; 1 ♂,

30.v.1914, 1 ♀, 31.v.1917, 2 ♂, 1 ♀, 2, 9.vi.1917, 1 ex., 26.v.1919, (Braun). Arkansas, Washington Co.; 1 ♀, 11.v.1966 (Hodges). Ontario, Sparrow lake; 8 ♂, 1 ♀, 12.vii.1926 (Braun). Ontario, Severn; on Ironwood; 2 ♂, 1 ♀, 16—20.vi.1925 (McDunnough). In SOO — Ontario, Trout Creek; on *Betula alleghaniensis* 1 ♀, 19.iii.1958, 1 ♀, 3.iv.1958.

Mines examined: In ANS — USA: Ohio, Still House Hollow; 2 mines on *Carpinus* sp. 24.viii.1909, B.538 (Braun).

Biology. — Mine. The mine begins as an ophionome — a narrow linear tract extending along the mid-rib or between two leaf veins and broadens, so filling the space between them. Later the mine widens further and becomes virtually a blotch. The frass is dark initially forming a broken line which becomes less compact and later diffuse. The mine is principally the same regardless which of the four host plants is attacked: *Carpinus caroliniana* (Hornbeam), *Corylus americana* (Hazel), *Ostrya virginiana* (Ironwood), *Betula alleghaniensis* (now: *B. lutea*) (Yellow Birch).

Voltinism. Bivoltine.

THE CASTANEA GROUP

The following eight taxa resemble each other particularly in the genitalia. Of special note are the following: very round pseuduncus, form of valves, complex cornuti and anellar processes in males; the thickened colliculum which lacks the characteristic sclerotised ring of other groups, very long posterior apophyses, especially in comparison with anterior ones, and the long narrow genitalia in females. Together with these features the similar venation with expanded costal margin of hind wing (fig. 1) and similar wing markings show this to be a discrete group. To this add the fact that all attack bark, as far as is known, but some form galls and others mine.

In many ways this group presumably corresponds with the sub-genus *Zimmermannia* Hering, 1940, adopted by several European workers. However the name is not used here because the diagnosis which separates the gall makers from the bark miners is invalid.

The group is called the *castaneae* group rather than by the older name *obrutella* because of the uncertainty about the latter life history and site of larval attack.

Ectoedemia obrutella (Zeller)

(figs. 1, 33, 34, 47)

Trifurcula obrutella Zeller, 1873: 316.

Trifurcula obrutella Zeller; Dyar, 1903: 547.

Ectoedemia obrutella (Zeller); Busck, 1913: 103.

Ectoedemia obrutella (Zeller); Braun, 1917: 200.

Ectoedemia obrutella (Zeller); Braun in Forbes, 1923: 83.

Ectoedemia obrutella (Zeller); McDunnough, 1939: 107 (no: 9782).

Nepticula bosqueella Chambers in Hayden, 1878a: 106 (syn. by Busck, 1903: 208).

Nepticula bosqueella (sic) Chambers; Chambers in Hayden, 1878b: 157.

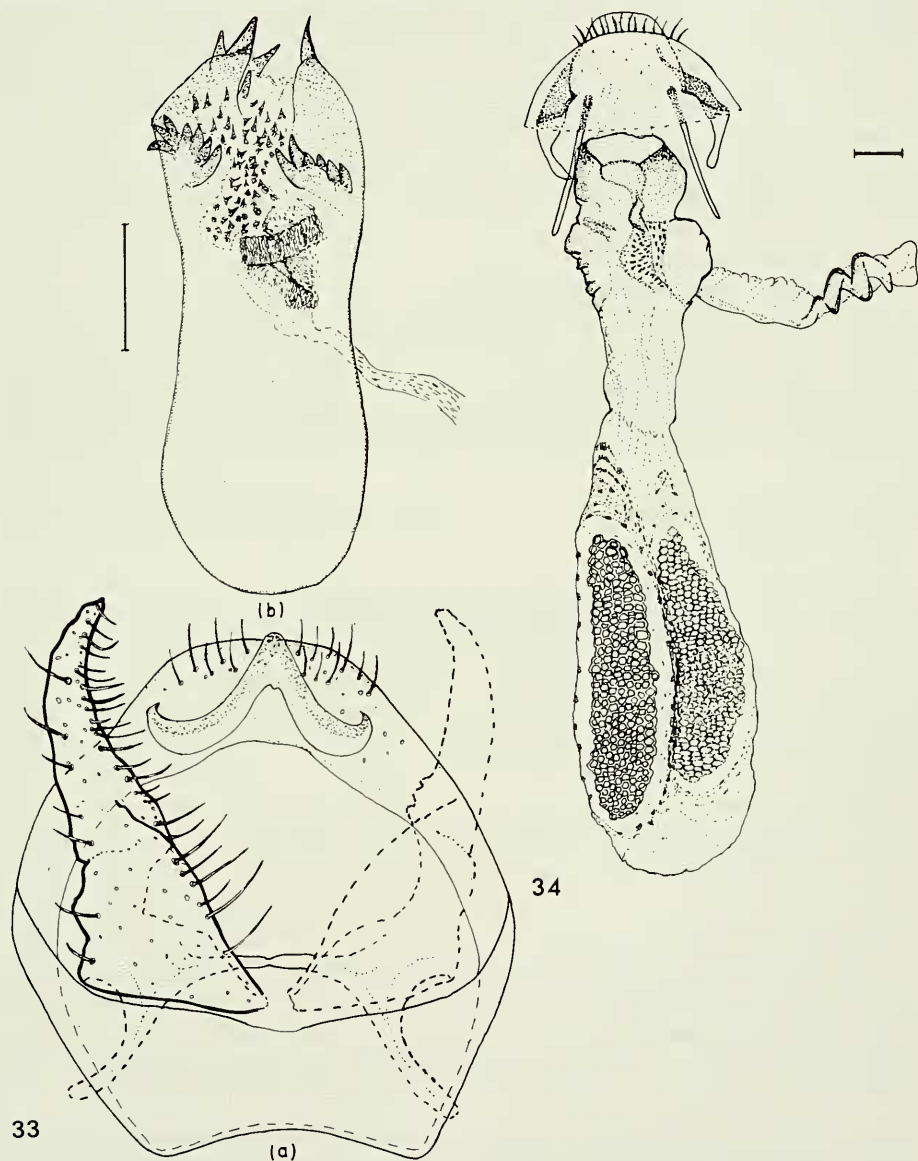
Opostega bosqueella (sic) Chambers; Dyar, 1903: 547 (mistaken genus).

Nepticula bosquella Chambers; Busck, 1903: 208 (cited under *Opostega albogaleriella*).

Ectoedemia bosqueella (sic) (Chambers); Braun, 1917: 200.

Ectoedemia bosquella (Chambers); Meyrick, 1928b: 426.

Description. — External features: ♂, ♀. Head: palps off-white; antennae sandy buff; tufts on front of head and vertex chocolate-brown; eye-caps creamy white; collar chocolate-brown. Thorax creamy white with scattered brown scales above. Abdomen greyish, shining metallic grey beneath. Forewings: ground colour of dorsal surface creamy white, weakly lustrous, irrorate with brown scales partic-



Figs. 33, 34. *Ectoedemia obrutella* (Zeller) Busck, ♂ (33) and ♀ (34) genitalia.

ularly dense basally and terminally giving the impression of a medial, pale fascia; fringe whitish, weakly lustrous. Hindwings: ground colour and fringe shining white; with a pale yellow brush of ciliae at the base of the costa; costa emarginated. Legs: buff with scattered yellow-gold reflections, darker behind; hind tibiae densely covered inwardly with sharp bristles. Fig. 47.

Wing expanse: ♂: 7.4—9.5 mm (44 specimens); ♀: 7.6—10.0 mm (27).

Genitalia: ♂ (fig. 33). Pseuduncus with a single lobe, broad and flattened. Gnathos: an inverted V as in fig. 33 (a); transverse ventral plate with a large medial process; dorso-lateral arms very broad and weakly arcuate. Vinculum: lateral arms broad, ventral plate broad. Saccus approximately half width of ventral plate, weakly bilobed. Valves reaching beyond the pseuduncus and tapering markedly. Transtillae: lateral arms broad; ventral arms very long, reaching beyond the saccus laterally; transverse arms fused to form a continuous strap constricted medially. Aedeagus: flask-shaped, just greater than length of the capsule; vesica with cornuti as many small denticles evenly distributed and with a plate of minute papillae as in fig. 33 (b); anellus comprising a pair of tooth-like spines with several denticles and pair of palmate plates laterally.

Female (fig. 34). Ductus bursae long, weakly sclerotised proximally with complex spiculate lobe as in fig. 34. Accessory sac small, arising from ductus medially and with terminally spiral accessory duct. Bursa copulatrix small, covered with irregular chains of pectinations on striations of the bursa; signum double comprising two equal sized ovate patches of hexagonal cells. Anterior apophyses short and broad. Posterior apophyses straight and narrow, reaching well beyond the anteriores.

Host plant: Several adults have been taken from the trunks of *Quercus* sp.

Mine: Not known.

Diagnosis. — The very large *al.ex.* and the pale ground colour separates this species from all other members of the genus except the *castaneae* group taxa. The tuft is darker than in *piperella* and the forewings less irrorate with brown, in *obrutella*. It lacks the iridescent scales of the hindwings found in *acanthella*. The saccus is more weakly bilobed than in *piperella* or *acanthella*. Compare figs. 33, 35 and 36 for other possible differences in the genitalia. See also diagnosis for *heinrichi* and *phleophaga*.

Discussion. — It is unfortunate we do not know more of the life history of this species. I (C.W.) suspect it is a bark miner. The genitalia are so very similar to those of the other oak bark miner *heinrichi* and the differences in externals, only slight, that how far they are taxonomically separate must remain in some doubt.

Originally described by Zeller (1873) as a member of *Trifurcula* Zeller, from a male and a female specimen collected by Boll in Texas. This species was also described by Chambers (1878a) from Texas material and given the name *Nepticula bosquella*. Chambers (1878b) then listed the name incorrectly as *bosqueella* (sic). Subsequently, Dyar (1903) listed *bosqueella* (sic) as a member of *Opostega* Zeller; since he gives no reason for the combination and no previous reference to the name can be traced it would seem to be an error by Dyar. Busck (1903) realised this error, also comparing material with Zeller's type of *Trifurcula obrutella* and synonymising *bosquella* with *obrutella*. Busck (1913) later reports, in his description

of *Ectoedemia castaneae*, that *obrutella* has important differences in wing venation from the type species of *Trifurcula* and he included *obrutella* in the genus *Ectoedemia*.

Distribution. — USA: — Texas, Pennsylvania, Massachusetts, Florida, Georgia, Alabama, Mississippi.

Material examined. — ♂ Type of *bosquella*: USA: “7/5; Collection of C.V. Riley; *Nepticula bosquella* Cham. Texas Ch.; Wlsm 1106 1882; Type no: 528 USNM”; slide no: CNC 3478; in USNM.

Other specimens: In MCZ — USA: Pennsylvania, Oak Station, Allegheny County; 1♂, 8.v.1913, 4♂, 2♀, 25.v.1913, 1♂, 5.vi.1910, 6♂, 2♀, 9.vi.1912 (Marloff). Pennsylvania, Jeannette; 1♂, 2.vi. (C.M. Acc. 2722, Klages). Pennsylvania, Pittsburgh; 1♂, 3.vi., 1♂, 7.vi.1904, 3♀, 20.vi. (C.M. Acc. 2723); 2♂, 3♀, 17.vi.1907 (C.M. Acc. 3495); On trunk of *Quercus* sp.; 2♂, 7♀, 17.vi.1907 (Kahl); 1♀, 17.vi.1906 (C.M. Acc. 4067, Engel). Pennsylvania, New Brighton; 1♀, 12.vi.1907, 1♂, 1♀, 14.vi.1907, 1♀, 15.vi.1907, 1♂, 27.vi.1907 (C.M. Acc. 4067). Massachusetts, Barnstable; 1♂, 26.vi.1958, 1♂, 4.vii.1958 (Kimball). In USNM—Florida, Oneco, Manatee Co.; 3♂, 5.v.1953 (Dillman). Gulf Coast Exp. Sta. Bradenton; 3♂, 1♀, 11 ex., 13—24.iii.1955 (Keisheimer). Siesta Key, Sarasota Co.; 10♂, 1♀, 9 ex., 15.iii.1953—3.iv.1960 (Kimball). Gainesville, Alachua Co.; 2♂, 14.iii.1955 (Morse), 1 ex., 1.v.1976. Pensacola; 1♂, 1 ex., 21 + 25.iii.1962, 1♂, 24.v.1964 (Hills). Mississippi, Choctaw Co.; 1♂, 22.iv.1976 (Heppner). Three other specimens probably belong here: Georgia, Crooked River St. Pk., Campden Co.; 1♂, 27.iv.1976 (Heppner). Alabama, Black Warrior River, Greenboro, Hale Co.; 1♀, 1 ex., 23.iv.1976 (Heppner).

Biology. — Immature stages unknown.

Ectoedemia acanthella sp.n.

(fig. 35)

Description. — External features: ♂. Head: palps off-white; antennae pale buff; tufts on front of head and vertex dark brown; eye-caps creamy white; collar dark brown. Thorax greyish white with scattered brown scales. Abdomen greyish white, shining metallic beneath. Forewings ground colour of dorsal surface greyish white with scattered brown scales, reflecting purple; fringe creamy white, weakly lustrous. Hindwings: ground colour and fringe buff with each scale shining pale bluish purple; costa emarginated. Legs: pale buff with some gold reflections; sharp bristles of hind tibiae pronounced.

Wing expanse: Holotype 7.2 mm.

Genitalia. ♂ (fig. 35). Pseuduncus with single flattened lobe, broad. Gnathos: V-shaped; transverse ventral plate broad with medial process; dorso-lateral arms very broad and arcuate. Vinculum: lateral arms broad, ventral plate broad. Saccus strongly bilobed with centre almost reaching edge of vinculum. Valves extending just beyond pseuduncus but arising high up and tapering markedly. Transtillae: lateral arms broad; ventral arms long, but not beyond anterior edge of saccus; transverse arms fused to form continuous strap, constricted medially. Aedaegus: flask-shaped, greater than length of capsule; vesica with cornuti as many small

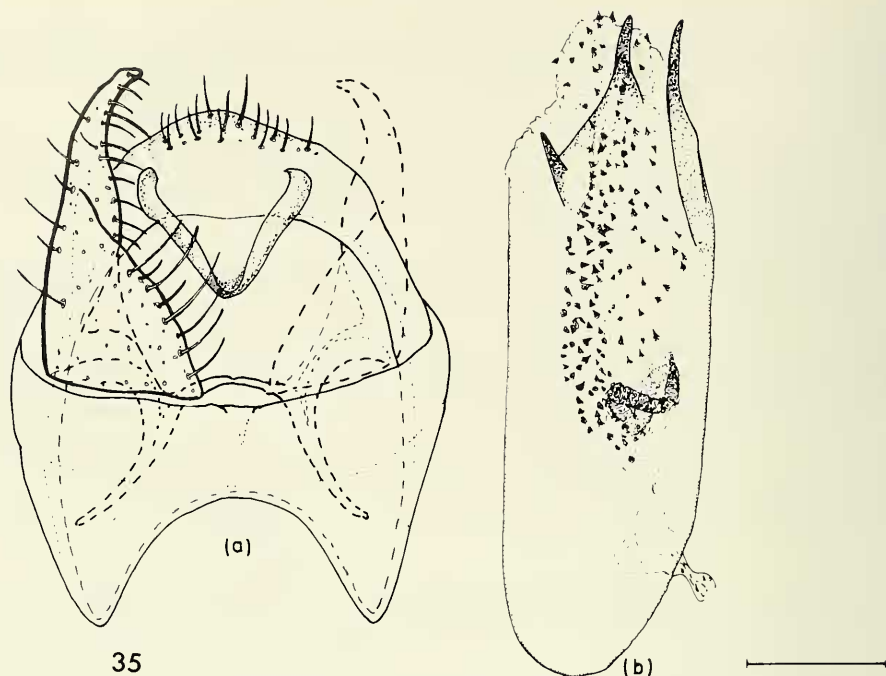


Fig. 35. *Ectoedemia acanthella* sp.n., ♂ genitalia.

denticles evenly distributed and with plate of minute papillae as in fig. 35(b); anellus comprising a number of tooth-like spines.

Female: Not known.

Host plant: Not known.

Mine: Not known.

Diagnosis. — External features as *obrutella* except that abdomen is creamy white. Forewings: ground colour of dorsal surface greyish white with scattered brown scales, reflecting purple; fringe creamy white, weakly lustrous. Hindwings: ground colour and fringe buff with each scale shining pale bluish purple. Genitalia as *obrutella* except that saccus is very narrow and markedly bilobed, each lobe as long as broad at base. Aedeagus: broad and regular, greater than length of capsule; vesica with cornuti as many small denticles evenly distributed and with a plate of minute papillae as in fig. 35; anellus comprising a pair of tooth-like spines but no palmate plates. Valves not so long and lack the inner corrugations and knobs of other species.

Discussion. — The differences given in the diagnosis, in particular the markedly bilobed saccus and the absence of the palmate anellar plates, exclude this specimen from *obrutella*, *piperella* sp.n., *heinrichi* and *castaneae*. The absence of inner knobs on the valves separates *acanthella* sp.n. from *phleophaga* and *mesoloba*.

Distribution. — USA: — New Jersey.

Material examined. — ♂ Holotype: USA; New Jersey, Essex County Pk.; "July 26 Trap W.D. Kearfott"; slide no: USNM 17287; in USNM.

Biology. — Immature stages unknown.

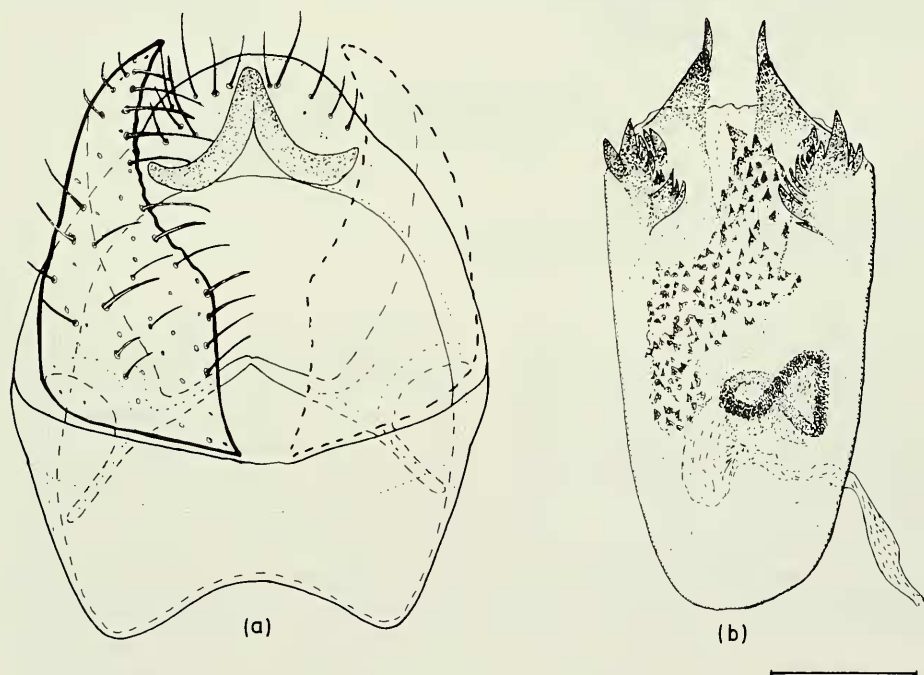
***Ectoedemia piperella* sp.n.**

(figs. 36, 45)

Description. — External features: ♂. Head: palps buff; antennae pale brown; tufts on front of head and vertex orange-ochreous; eye-caps shining white; collar pale brown. Thorax yellow-cream, irrorate with purplish brown. Abdomen grey, shining metallic grey beneath. Forewings: ground colour of dorsal surface yellowish, irrorate with purplish brown scales particularly at the base and along the costal margin, reflecting purple; fringe creamy white, shining metallic grey. Hindwings: ground colour and fringe buff, shining metallic grey; pale yellow brush of ciliae at the base of the costal margin; costa emarginated. Legs: tibiae of fore and midlegs dark brown, otherwise buff and shining metallic grey behind; hind tibiae densely covered inwardly with sharp bristles. Fig. 45.

Wing expanse: ♂: 6.4—8.2 mm (3 specimens). Holotype: 7.2 mm.

Genitalia: ♂ (fig. 36). Pseuduncus with a single, broad and flattened lobe. Gnathos: an inverted V as in fig. 36(a); transverse ventral plate with large medial process; dorso-lateral arms broad and weakly arcuate. Vinculum: lateral arms broad; ventral plate broad. Saccus as wide as ventral plate, bilobed. Valves reaching beyond the pseuduncus, broad basally but tapering markedly, inner margin concave distally. Transtillae: lateral arms broad; ventral arms long and narrow, reaching beyond the ventral plate; transverse bars fused to form a continuous strap, constricted medially. Aedeagus: broad and regular in width, approx-



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Fig. 36. *Ectoedemia piperella* sp.n., ♂ genitalia.

imately equal to length of capsule; vesica with cornuti as many small denticles evenly distributed and with a plate of minute papillae as in fig. 36(b); anellus comprising a pair of tooth-like spines with several large single spines and a pair of palmate plates laterally.

Female: Not known.

Host plant: Not known.

Mine: Not known.

Diagnosis. — Resembles both *obrutella* and *acanthella* but differs in the more yellowish ground colour of the dorsal aspect and the more dense irroration of the forewings, in *piperella*. It lacks the iridescent scales on the hindwings found in *acanthella*. The saccus is more markedly bilobed than in *obrutella* but less than in *acanthella*. The stouter valves and the relatively short aedeagus separate this from *obrutella*.

The colours of the vertex and tufts on front of the head differ in this species from *heinrichi* and *castaneae*. It also has purple and grey reflections on the wings which are missing in these latter species. The male genitalia are similar but compare figs. 36 and 37 for differences. *E. piperella* can be diagnosed from *phleophaga* and *mesoloba* by the absence of knobs on the inner surface of the valves.

Distribution. — USA: — Arkansas.

Material examined. — ♂ Holotype: USA: "Devil's Den St. Pk., Washington Co. Ark., 9.vi.1966 R. W. Hodges"; slide no: USNM 17285; in USNM. Paratypes: In USNM — USA: same data as Holotype; 3♂, 28.v.1966, 9.vi.1966, 16.vi.1966 (Hodges); slide no: USNM 17286.

Biology. — Immature stages unknown.

***Ectoedemia heinrichi* Busck**

(figs. 37, 38, 61)

Ectoedemia heinrichi Busck, 1914a: 149.

Ectoedemia heinrichi Busck; Braun, 1917: 199.

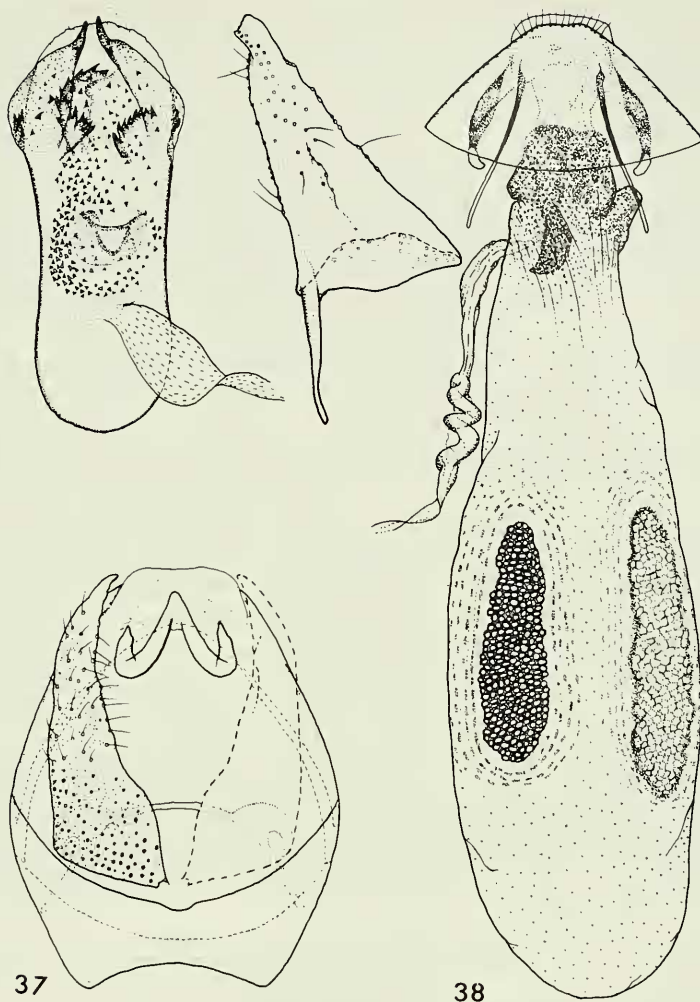
Ectoedemia heinrichi Busck; Braun in Forbes, 1923: 83.

Ectoedemia heinrichi Busck; McDunnough, 1939: 108 (no: 9786).

Description. — External features: ♂ ♀. Head: palps buff; antennae light brown; tuft on front of head and vertex dark brown; eye-caps and collar white. Thorax white with some brown-tipped scales. Abdomen pale brown. Forewings: irrorate with white and brown scales, variable on each wing as well as between specimens. Hindwings: greyish buff; undersurface brownish buff. Legs buff. Fig. 61.

Wing expanse: ♂: 8.0—10.0 mm (15 specimens); ♀: 8.0—10.5 (11). Holotype: 8.5 mm.

Genitalia: ♂ (fig. 37). Pseuduncus with a single broad lobe as in fig. 37 (a). Gnathos: W-shaped, but lateral arms shorter than inner arms. Vinculum: lateral arms broad; ventral projections narrow. Saccus broad and weakly bilobed. Valves extending as far posteriorly as pseuduncus, triangular and slightly arcuate. Transstilla: a narrow inverted U-shape; lateral arms broad and short; ventral arms narrow, projecting anteriorly well beyond margin of ventral plate; transverse bars fused to form a narrow arcuate strap. Aedeagus: approximately equal to length of



Figs. 37, 38. *Ectoedemia heinrichi* Busck, ♂ (37) and ♀ (38) genitalia.

genitalia; vesica with cornuti as small denticles and plate of minute papillae as in fig. 37(b); anellus with pair of tooth-like spines and a pair of palmate plates. Patches of scent scales present, one pair overlapping genitalia.

Female (fig. 38). Ductus bursae short, without sclerotised colliculum, but with enlarged spiculate lobe. Accessory duct arising from dilation of ductus and distally spiralled. Bursa copulatrix large, covered with pectinations; signum double, comprising two relatively small, but equal-sized patches of cells. Anterior apophyses comparatively short and broad. Posterior apophyses straight and narrow, very long, extending below swelling of ductus.

Host plant: *Quercus palustris* (Pin Oak).

Mine: An oval spiral in the bark.

Diagnosis. — This species is very similar to *castaneae*, even the larva and espe-

cially the genitalia, although *heinrichi* appears to be a slightly larger species than *castaneae*. They are very difficult to diagnose with respect to morphology, but with regard to biology, *heinrichi* mines the bark of *Quercus*, whereas *castaneae* makes galls on chestnut. Another similar species, *obrutella*, is distinguished from *heinrichi* by a darker, brown, collar and paler hindwings and there are also small differences in the male and female genitalia (see figs. 33 and 34).

Discussion. — The wing markings are variable and the genitalia similar to those of other species in the group. The life history of *heinrichi* is well known and was first worked out by Carl Heinrich and detailed by Busck (1914a). This is fortunate since its separate identity is most strongly supported by what is known of its biology.

Distribution. — USA: — Virginia, Ohio, Kentucky, Illinois.

Material examined. — ♂ Lectotype: USA: Virginia, "Falls Church, Va; Reared May 22-14, C. Heinrich; Hopk. US 12107; *Ectoedemia heinrichi* cotype Busck; USNM No. 19039; slide no. 16935; *Quercus palustris*"; in USNM. Paralectotypes: In USNM-data as lectotype; 9♂, 4♀, 1 ex., 8.v.1914 — 5.vi.1914.

Other specimens: In ANS—USA: Ohio, Cincinnati; 4♂, 7♀, 4.vi.1903, 21.vi.1904, 3.vi.1905, 15.v.1906, 30.v.1906, 7.vi.1906, 20.v.1917, 5.vi.1917, 14.vi.1917 (Braun). In USNM—USA: Illinois, Putnam Co., 1♂, 25.v.1975 (Glenn). 1♂, in ANS, data as lectotype, but not labelled cotype, was presumably given to Braun in exchange for 1♂ from Cincinnati, Ohio, 4.vi.1913, in USNM.

Mines examined: In USNM—USA: Numerous mines (and pupae) from Busck collection.

Biology. — Egg. Laid on the bark of young branches.

Mine. I have only seen this mine on the twigs of young saplings (C.W.), although Busck (1914a: 149) reported finding it also on the outer branches of larger trees. It is a narrow linear track coiled into an oval spiral with the empty egg at the centre.

Larvae. Matures in the autumn, October and November, when it leaves the mine and falls to the ground.

Pupa. Cocoon flattened, oval, reddish brown, 2—2.5 mm × 3—4 mm.

Voltinism. Univoltine. Adults normally emerge in May—June. In the laboratory specimens often emerge two or three months earlier.

***Ectoedemia castaneae* Busck** (fig. 62)

Ectoedemia castaneae Busck, 1913: 103.

Ectoedemia castaneae Busck; Braun, 1917: 198.

Ectoedemia castaneae Busck; Braun in Forbes, 1923: 83.

Ectoedemia castaneae Busck; McDunnough, 1939: 108 (no. 9784).

Description. — External features: ♂ ♀. Head: palps buff; antennae brown; tuft on front of head chocolate brown, vertex brown; eye-caps white; collar white. Thorax irrorate with brown and white scales. Abdomen brown. Forewings: ground colour of dorsal surface white, but many scales are tipped with dark brown, making the surface variously irrorate. Hindwings: brownish buff; undersurface brownish grey. Legs buff or brownish buff. Fig. 62.

Wing expanse: ♂: 6.5—8.0 mm (3 specimens); ♀: 7.0—8.0 mm (4); Lectotype: 6.5 mm.

Genitalia: ♂, ♀. Similar to those of *heinrichi* which are illustrated in figs. 37 and 38.

Host plant: *Castanea* sp. (Chestnut).

Mine: In form of small galls around young twigs.

Diagnosis. — As discussed in the diagnosis of *heinrichi*, the genitalia of both males and females of these two species are very similar; separate figures are not helpful and diagnosis on these features is too difficult. However, *castaneae* and *heinrichi* do differ in their life history and host plant and possibly also in size. Since *castaneae* is so similar to *heinrichi* in externals and genitalia the diagnosis for the latter species with respect to *obrutella* also holds for *castaneae*, which has a lighter, white, collar and darker hindwings than *obrutella* and similar small differences in the genitalia.

Discussion. — The life history of this species as a gall-former enables us to recognize its separate identity from *heinrichi*.

Distribution. — USA: — Virginia, Pennsylvania, Kentucky.

Material examined. — ♂ Lectotype: USA: Virginia, "Vietch, Va., 23 April 1913, Snyder; USNM No. 16333; slide no. 16713; *Ectoedemia castaneae* Busck cotype; 11236 Hopkins US"; in USNM. Paralectotypes: In USNM—data as lectotype; 1♂, 2♀, 23—24.iv.1913. Other specimens: In USNM—USA: Pennsylvania, New Brighton; 2♂, 2♀, 14.vi.1907 (Meyrick Museum).

Biology. — Egg. Laid on the bark of *Castanea* twigs.

Larva. Typically flattened, with limb buds on segments 3 to 10 and 13, but very rudimentary on segment 5.

Mine. No mine is made as such, but more a spherical gall resembling in form and size "the egg masses of the forest tent-caterpillar" (Busck, 1913: 103).

Voltinism. Bivoltine or, more probably, trivoltine.

***Ectoedemia phleophaga* Busck**

(figs. 39, 40, 63)

Ectoedemia phleophaga Busck, 1914b: 3.

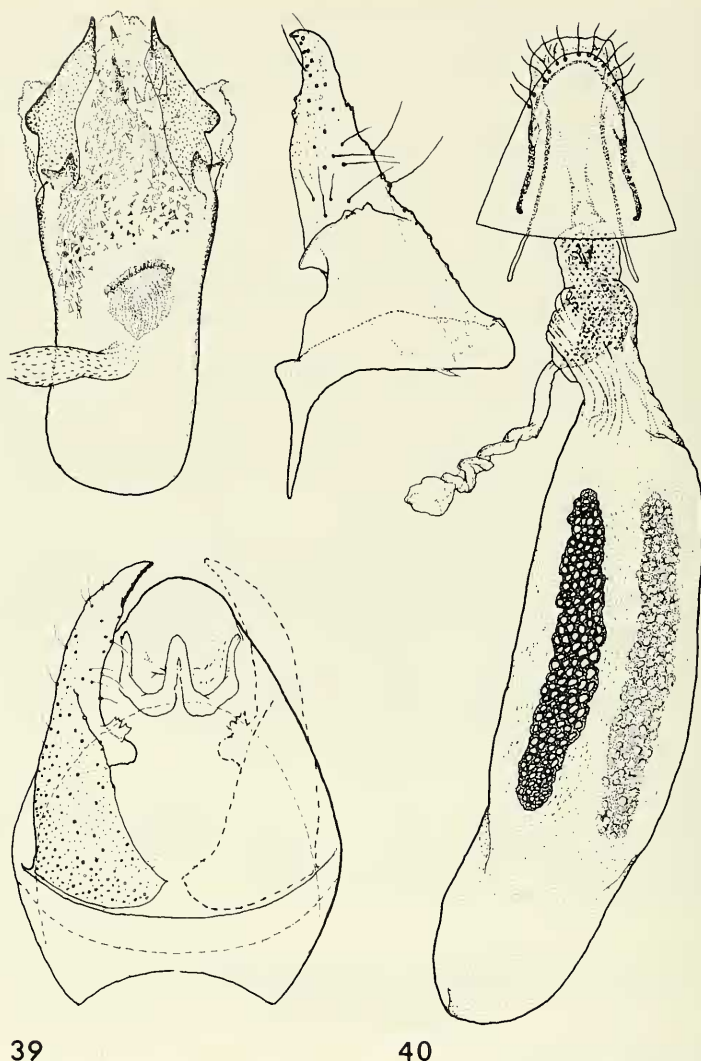
Ectoedemia phleophaga Busck; Braun, 1917: 198.

Ectoedemia phleophaga Busck; Braun in Forbes, 1923: 83.

Ectoedemia phleophaga Busck; McDunnough, 1939: 108 (no. 9785).

Description. — External features: ♂ ♀. Head: Palps buff; antennae light brown; tuft on front of head and vertex white or buff; eye-caps white; collar brown. Thorax brown. Abdomen pale brownish buff. Forewings: brown with some white scales, sometimes forming a postmedial and antemedial spot and occasionally a postmedial fascia. Thorax and basal half of forewing sometimes with dark bluish fuscous reflections. Hindwings and ventral surface brownish buff. Legs buff. Fig. 63.

Wing expanse: ♂: 8.3—10.5 mm (32 specimens); ♀: 8.7—10.6 mm (27); lectotype: 9.0 mm.



Figs. 39, 40. *Ectoedemia phleophaga* Busck, ♂ (39) and ♀ (40) genitalia.

Genitalia: ♂ (fig. 39). Pseuduncus with single rounded lobe. Gnathos: W-shaped with lateral arms as long as inner arms. Vinculum: lateral arms and ventral plate narrow. Saccus broad, weakly bilobed, concave anteriorly. Valves: fractionally longer than genitalia; narrowly arcuate, with median boss. Transtillae: lateral arms short and narrow; ventral arms short; transverse bars fused centrally. Aedeagus: equal to length of capsule; vesica with many denticles and with large plate of small papillae as in fig. 39(b); anellus comprising a pair of long, broad spines and pair of simple plates laterally.

Female (fig. 40). Ductus bursae long, colliculum not heavily sclerotised. Accessory duct arising from ductus bursae and spiral distally. Bursa copulatrix long, with

fine pectinations. Signum double, comprising a pair of long, reticulate patches, approximately equal in area. Anterior apophyses long, arcuate and narrow. Posterior apophyses very long and straight, reaching well beyond the anteriores.

Host plant: *Castanea dentata*.

Mine: A bark ophionome.

Diagnosis. — This species is similar to *castaneae* but *phleophaga* is easily distinguished by its larger size, darker wings and lighter tufts and abdomen. The white or buff tufts also distinguish it from *obrutella* and *heinrichi* in which they are dark brown. Considering the male genitalia, *phleophaga* is the only bark-miner with the inner arms of the W-shaped gnathos equal in length to the lateral arms. It also has a central boss on the middle of the valves as does *mesoloba*, in which it is more simple in form. The female genitalia are typical of the *Ectoedemia* species attacking bark described here: they lack the strongly sclerotised colliculum and have very long posterior apophyses. It is possible that *phleophaga* can be diagnosed by the anterior apophyses, which are narrower and straighter than in other similar species, especially *obrutella*, *heinrichi* and *castaneae*.

Discussion. — Again knowledge of the life history allows us to separate *phleophaga* with certainty from other species associated with bark, especially *castaneae*, which is also found on chestnut. The life history was worked out by Busck (1914b), together with Snyder and Heinrich and independently at about the same time, by Ruggles (1913). Because of its pest status (see Biology), *phleophaga* has been given the common name of "Chestnut bastminer".

Distribution. — USA: — Virginia, Pennsylvania, Massachusetts?

Material examined. ♀ Lectotype: USA: Virginia, "Falls Church Va., 22 Sept. 1913; USNM No. 16900; slide no. 16633; *Castaneae dentata*; 11245 Hopk US"; in USNM. Paralectotypes: In USNM—data as lectotype, with cotype labels; 11♂, 8♀, 12—22.ix.1913.

Other specimens: In USNM—data as lectotype; 21 ♂, 19 ♀, 2 ex., 22.vi-ii—15.ix.1914.

Biology. — Egg laid on the bark.

Mine. In the lower layers of the bark and in the cambium. A slender, contorted, serpentine mine; a number of centimetres long and a few millimetres wide, but the width varying throughout its length.

Larva. On hatching from the egg, the larva burrows in the bark until the second or third instar. By this time winter causes it to hibernate in its tunnel and activity starts again in the spring. When fully grown it is white with dark brown sclerotisations of the head capsule, thoracic, sternal and anal plates. In April to early June the larva tunnels out and drops to the ground. Only then does the tunnel become apparent by means of the exit hole.

Pupa. The cocoon is spun amongst the debris on the ground or in a burrow in loose soil. It is a reddish brown, closely woven cocoon, rather seed-like.

Voltinism. The species seems to be univoltine, the adults appearing in August and September.

Pest status. According to Ruggles (1913: 852), *phleophaga* is associated with the spread of the chestnut bark disease, *Endothia parasitica*. An enormous number of larval exit holes appear at a time of year when blight spores of the fungus are parti-

cularly prevalent (see also the Report of the State Forester of Massachusetts on the Chestnut Bark Disease, 1912).

***Ectoedemia chlorantis* Meyrick**
(figs. 41, 46)

Ectoedemia chlorantis Meyrick, 1928a: 462.

Ectoedemia chlorantis Meyrick; McDunnough, 1939: 108 (no: 9787).

Description. — External features: ♀. Head: palps pale buff; antennae buff with

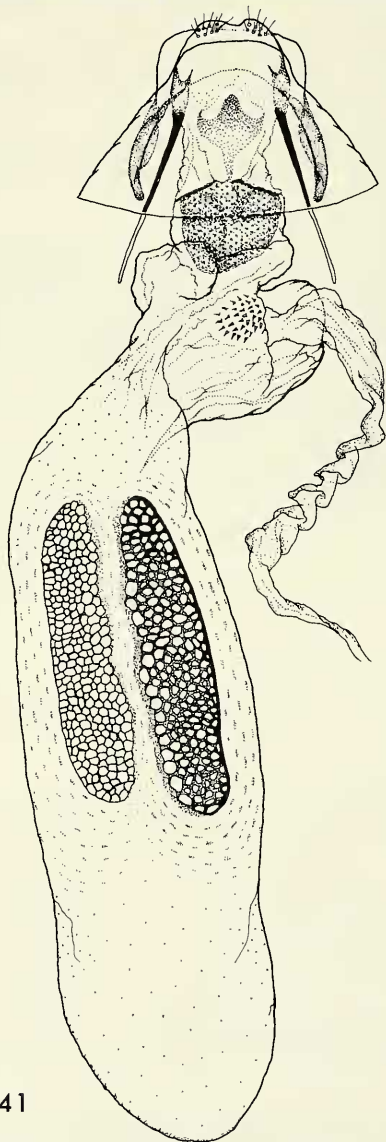


Fig. 41. *Ectoedemia chlorantis* Meyrick, ♀ genitalia.

darker banding; tuft on front of head and vertex yellowish brown; eye-caps whitish; collar brownish buff. Thorax buff, irrorate with light grey and abdomen presumably similar. Forewings yellowish buff, speckled lightly with light grey or fuscous and more heavily speckled in distal half. Hindwings and ventral surface buff, tinged with grey. Legs buff, irrorate with fuscous on outer surface. Fig. 46.

Wing expanse: Holotype: 9 mm.

Genitalia: ♀ (fig. 41). Ductus bursae short and broad, with sclerotised colliculum (not ring-shaped) and with spicules. Accessory duct spiral medially. Bursa copulatrix long, with fine pectinations; signum double, comprising two approximately equal-sized ovate patches of cells. Anterior apophyses broad and arcuate. Posterior apophyses particularly long and narrow.

Host plant: Not known.

Mine: Not known.

Diagnosis. — The forewing of *chlorantis* has light background colouring, peppered with darker irrorations, similar to that of *mesoloba*. There is not enough material to know whether there are reliable diagnostic differences in the externals of these two, but *chlorantis* is possibly a much larger species. The female genitalia of *chlorantis* lack the characteristic colliculum of most leaf- and petiole-mining species, although there is a weak sclerotisation. The long posterior apophyses are also of note as a possible indication of a bark-miner.

Discussion. — This species is only known from the female holotype, which appears to be distinct. It should be no great problem for additional material to be collected in the type-locality to provide us with better information.

Distribution. — Canada: — Ontario.

Material examined. — ♀ Holotype: Canada: Ontario, "Toronto, September (Parish)"; in BM(NH).

Biology. — Unknown.

***Ectoedemia mesoloba* Davis**

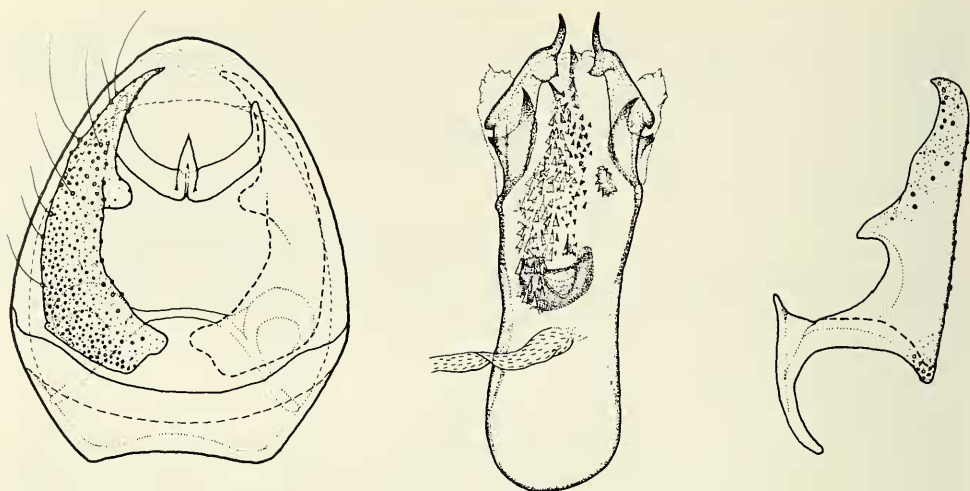
(figs. 42, 50)

Ectoedemia mesoloba Davis, 1978: 209.

Description. — External features. ♂. Head: palps buff or white; antennae whitish proximally, brown distally, but paler above; tuft on front of head, vertex and eye-caps buff to white. Thorax white with some pale brown above. Abdomen buff with much pale brown marking above. Forewings: irrorate with buff and pale brown. Hindwings and ventral surface pale buff. Legs buff with some brown scales dorsally, particularly on pro- and mesothoracic legs. Fig. 50.

Wing expanse: Holotype: 5.5 mm.

Genitalia. ♂ (fig. 42). Pseuduncus with a single, unspecialised, rounded lobe as in fig. 42(a). Gnathos: W-shaped with central boss shorter than lateral arms. Vinculum: broad and short, anteriorly slightly concave. Saccus broad and hardly concave. Valves not extending further than pseuduncus, narrow and lobed halfway along costal margin. Transtillae: strongly arcuate lateral arms broad and short; ventral arms extend well forward, beyond margin of ventral plate; transverse bars fused centrally. Aedeagus: equal in length to or slightly longer than genitalia;



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Fig. 42. *Ectoedemia mesoloba* Davis, ♂ genitalia.

vesica with large cornuti and plate of minute papillae; anellus with pair of tooth-like spines and spinose plates laterally, as in fig. 42(b).

Female: Unknown.

Host plant: Not known.

Mine: Not known.

Diagnosis. — Externally, *mesoloba* is mainly light coloured, like *chlorantis*, but *mesoloba* is very much smaller. The male genitalia have the central part of the gnathos markedly shorter than the lateral arms. This feature together with the presence of a central boss on the valves separates *mesoloba* from the other *Ectoedemia* species reported here, especially the bark-miners whose genitalia are so similar to those of *mesoloba*. There is also a boss on the valves in *phleophaga* male genitalia, but it is more complex in form.

Discussion. — Although *mesoloba* is similar to *chlorantis* the type-localities are widely separated and it seems unlikely that they occur throughout the intervening area. Davis, who recently described *mesoloba*, feels that the diagnostic features and type-locality are so characteristic that the specimen should be given specific status. It is unfortunate that more material is not available. I suspect it is a bark-miner, although it is somewhat smaller than the other bark-miner species discussed here (C.W.).

Distribution. — USA: — Florida.

Material examined. — ♂ Holotype: USA: "Pensacola, Escambia Co., Florida, Nov. 12.1961, Shirley Hills"; slide no. 16835; in USNM.

Biology. — Not known.

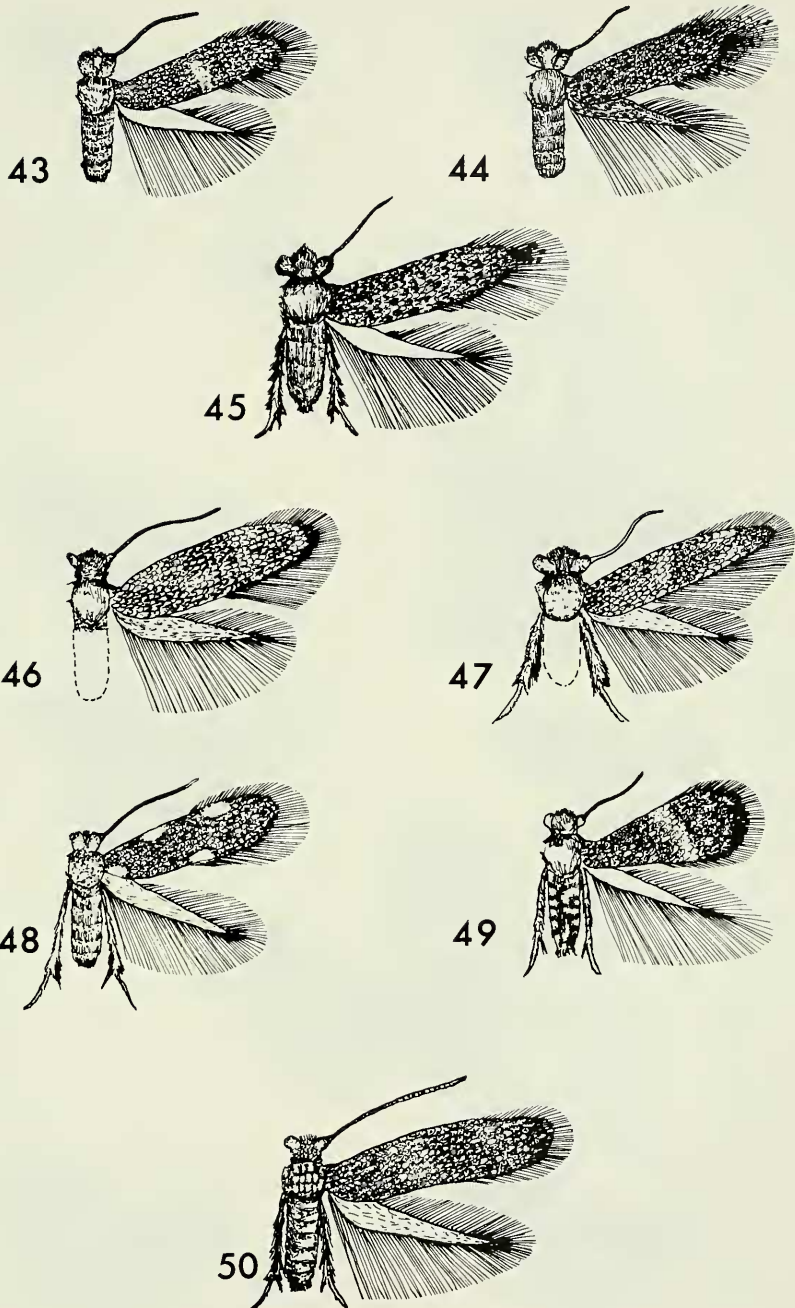
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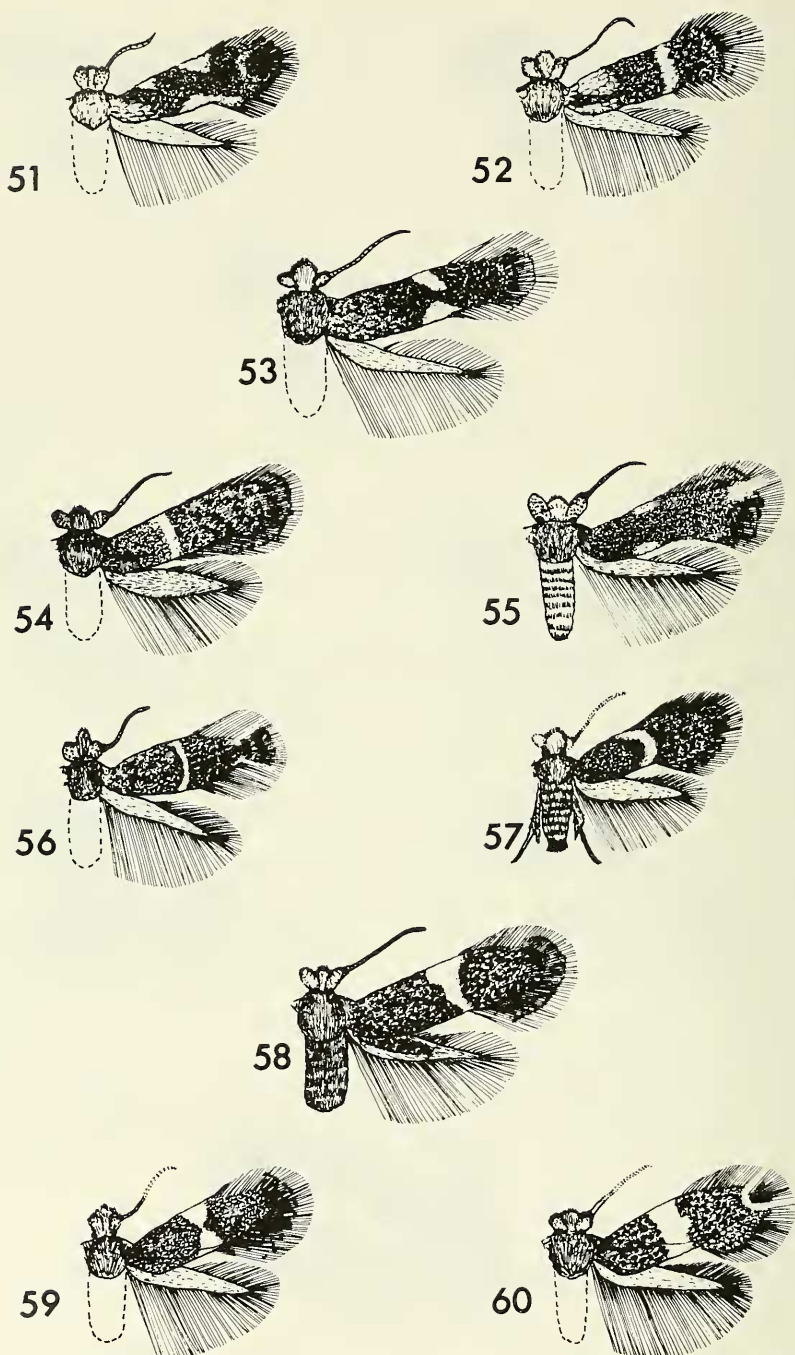
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¹⁾ Although the publication is dated Nov. 1861, it seems likely that this was the date that the Entomological Society of Philadelphia agreed on the contents for the issue. The printed copy was first received by the society's librarian on 13 Jan. 1862, so publication falls somewhere between and almost certainly close to Jan. 13. Further explanation may be found in Brown, F. M., 1964, "Dates of publication of the various parts of the Proceedings of the Entomological Society of Philadelphia", *Trans. Amer. ent. Soc.* 89: 305-308.

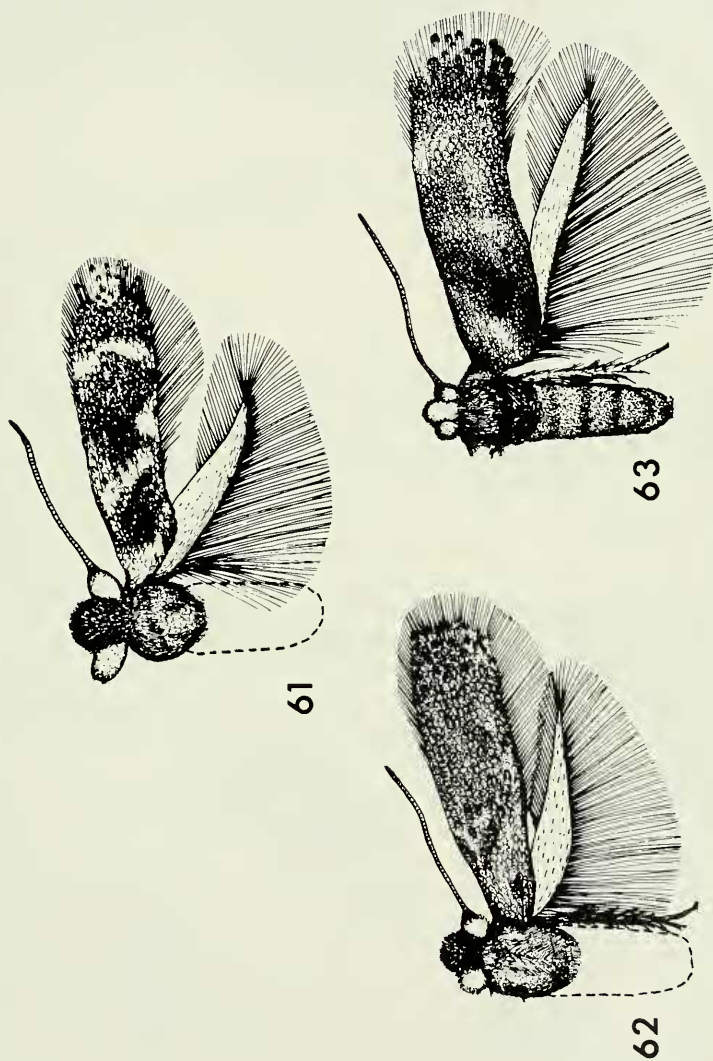
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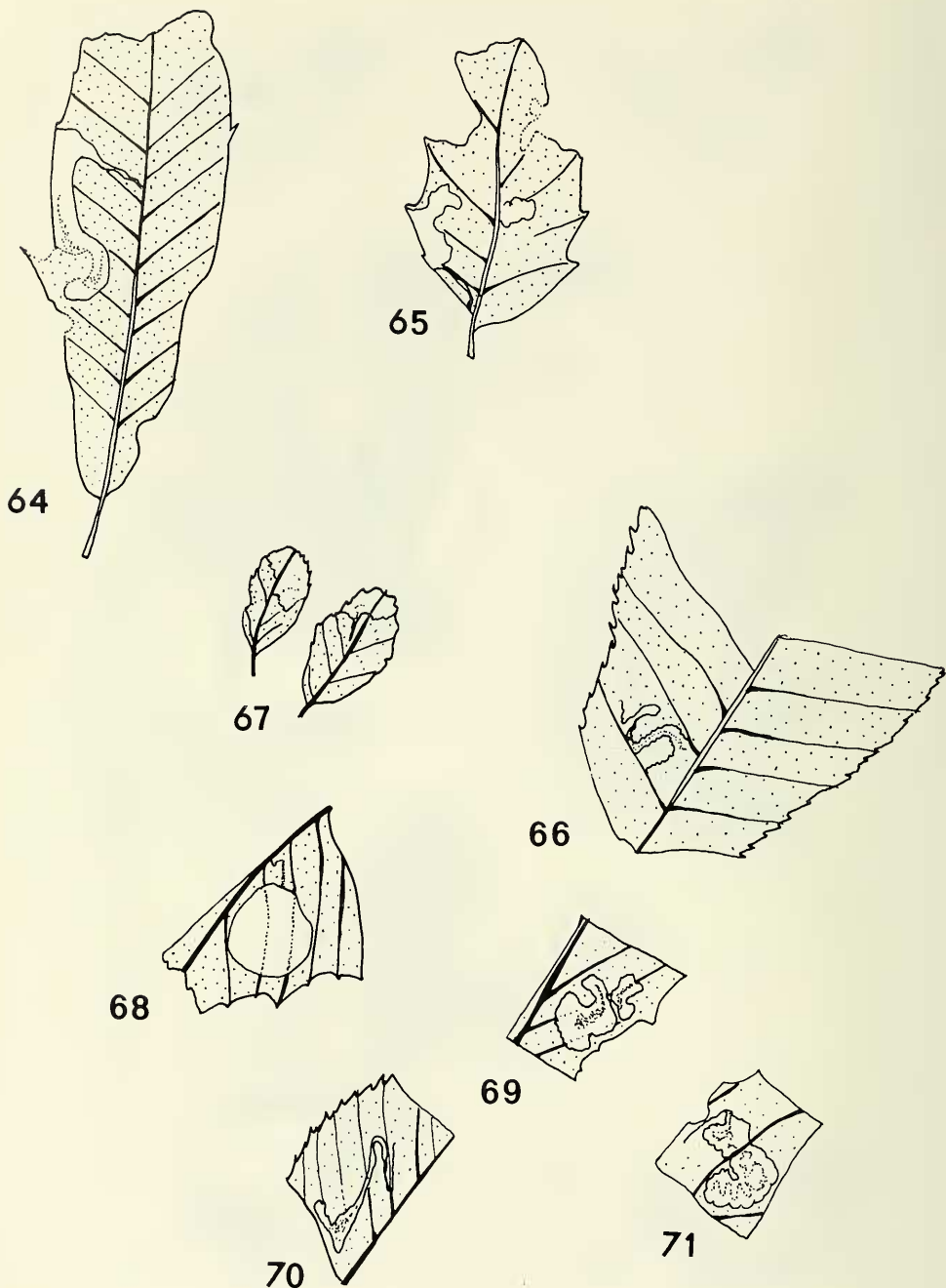
Figs. 43—50. *Ectoedemia* species, external features. 43, *E. lindquisti* (Freeman); 44, *E. canutus* Wilkinson & Scoble; 45, *J. piperella* sp.n., ♂; 46, *E. chlorantis* Meyrick, ♀; 47, *E. obrutella* (Zeller) Busck; 48, *E. quadrinotata* (Braun); 49, *E. rubifoliella* (Clemens); 50, *E. mesoloba* Davis, ♂.



Figs. 51—60. *Ectoedemia* species, external features. 51, *E. trinotata* (Braun), ♂; 52, *E. marmaropa* (Braun), ♀; 53, *E. platanella* (Clemens), ♂; 54, 55, *E. similella* (Braun), ♂, Ohio form (54) and Florida form (55); 56, 57, *E. virgulae* (Braun), ♀, Ohio form (56), ♂, Florida form (57); 58, 59, *E. nyssaefoliella* (Chambers), ♂ (58), ♀ (59); 60, specimen 8, ♂.



Figs. 61—63. *Ectoedemia* species, external features. 61, *E. heinrichi* Busck; 62, *E. castaneae* Busck; 63, *E. phleophaga* Busck.



Figs. 64—71. Leaf-mines. 64, 65, fossil leaf-mines from the lower Eocene (loaned from P. Opler); 66—71, *Ectoedemia* mines; 66, *E. trinotata* (Braun) on *Carya cordiformis*; 67, *E. marmaropa* (Braun) on *Rosa woodsii*; 68, *E. platanella* (Clemens) on *Platanus occidentalis*; 69, *E. similella* (Braun) on *Quercus palustris*; 70, *E. virgulae* (Braun) on *Corylus americana*; 71, *E. nyssaefoliella* (Chambers) on *Nyssa sylvatica*. All natural size.